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BLOOD PRESSURE IN GENERAL ANESTHESIA.*

E. I. McKesson, M.D.,
Toledo, Ohio.

Since the anesthetist is the only person in the surgical team who is at liberty during an operation to make the necessary tests to determine the condition of the patient, he should avail himself of every practical means by which such information may be obtained. His prognosis, if based upon reliable data, will be a valuable guide to himself and the surgeon, who may vary his operation to meet existing conditions and thus save lives both on the table and afterwards.

Among those tests, blood pressure stands out as the most reliable indicator of changing cardio-vascular conditions during an operation, and will show the progress of such conditions as shock long before it may be detected by feeling and counting the pulse. The treatment of shock, once well advanced, has been notoriously inefficient, and if anything is to be done it must be recognized and the treatment instituted before the heart is exhausted by rapid contractions in its attempt to hold up the blood pressures.

During the past eight years I have charted more than five thousand cases, taking the blood pressures, pulse and respiration every few minutes during each operation, and while I must not be understood to belittle other methods of interpreting the patient's condition, I believe that the value of blood pressure during an operation has not been appreciated by the large majority of anesthetists and surgeons.

The blood pressures of any patient vary as a whole, in response to changing requirements of comparatively slight importance. These changes from the patient's normal reading, however, rarely exceed 10 per cent., while those pointing to unusual, or pathological significance may be very great. The interpretation, therefore, of a *group* of blood pressure readings of a patient is based more upon these abnormal variations, whether they be high or low, than upon any one reading. During an operation to take one reading as a sign of the patient's condition, would generally be misleading, but a group of readings will show the *tendency* towards shock in its various manifestations, the reaction of the patient to various procedures in the operation, and especially to the influence of the anesthetic.

Unvariable pressures during operations are the result of most painstaking technic on the part of the surgeon, anesthetist, and every one concerned in carrying out a shock-free technic. Such results cannot be obtained by accident, but it is necessary to eliminate certain procedures peculiar to the individual surgeon and anesthetist, which by means of blood pressure readings are found to be frequently productive of more or less disastrous results, either at the time, or during the few days succeeding the operation. For example, no surgeon is willing to admit that he is rough in the belly, and no anesthetist will admit that he generally overdoses his patients, but a series of cases where the blood pressures are frequently taken in each case, will commend or condemn their technic most emphatically. If circulatory depression frequently occurs even in minor degree, it is due to faulty technic and the cause should be discovered and removed; it may necessitate a new technic in several particulars.

For the sake of convenience, the cuff is *fastened* upon the arm by pinning the folds together with a safety pin, and the stethescope bell is also held in place over the artery by means of a three-quarter inch elastic web passing around the arm. The webbing is buckled just tight enough to hold the diaphragm in place. The stethescope is provided with about two feet of rubber tubing leading to the ear pieces so that the auscultatory method may be carried out by the anesthetist without disturbing sterile dressings, or in the least inconveniencing himself.

We shall not discuss the technic of taking blood pressure, which has been so frequently explained and is familiar to all. It is, however ,important to understand that the pulse pressure from the standpoint of the anesthetist, is quite as important as the diastolic pressure, which makes it necessary to take both systolic and diastolic readings at each determination. It is also important in our work that these readings for comparison be made in either expiration, or in inspiration since respiration exerts considerable influence on the blood pressure in many cases under general anesthesia. Personally, I make both determinations in expiration, but if the respiratory variation of blood pressure is unusual I also chart the readings in inspiration.

A few points in physiology must be understood, which are of special interest clinically in the interpretation of the condition of the patient by means of blood pressure tendencies.

The physiology of the circulation is applied physiology of muscle, and those influences which control or modify the action of muscle, influence the speed of the blood, the volume moved, and the pressure developed.

* Read during the Third Annual Meeting of the American Association of Anesthetists, San Francisco, June 21, 1915.

We find the greatest development of muscle, of course, in the heart; while in the great arteries, muscular tissue is displaced by passive elastic tissue. In the very small arterioles muscle again becomes relatively prominent in the wall. It is in this later region that the *control* of the flow of blood through any group of organs occurs; it is here that the principal dilitation or congestion of the arterial system takes place to accommodate the extra volume of blood, which is thrown into the arteries at each heart contraction; it is also in this region that the disturbance of balance between peripheral resistance, and the output of the heart is often initiated.

The state of tonus in the arteriole is, no doubt, the result of at least three kinds of stimulation: (1) the mechanical stimulation due to repeated sudden stretchings of the arteriolar muscle by the pulse wave; (2) chemical stimulation by carbon dioxid, adrenalin and other drugs; (3) nervous stimulation. For this reason, any influence which reduces the pulse impact, or pulse pressure, even though an increased pulse rate maintains an equivalent or greater output of blood, is a cause of arteriolar dilitation, or congestion which may be of such general distribution as to be the cause of shock. This is one of the results of pushing an anesthetic to deep relaxation, which reduces the pulse pressure in the same way and at the same time that the skeletal muscle is relaxed with only a difference in degree.

The normal relation of pulse pressure to diastolic pressure is expressed by the fraction ½; that is, in a normal patient whose systolic pressure is 120 and diastolic 80, which would make a pulse pressure of 40, the ratio of pulse pressure to diastolic is 40-80, or ½. The heart load, or pulse pressure, therefore, is normally 50 per cent. of the diastolic pressure. This ratio is maintained in spite of quite large variations in the actual readings exhibited by the patient with a normal vascular system. This ratio is of importance in prognosis, because the patient who presents a pulse pressure equal to or greater than the diastolic pressure will not tolerate low blood pressure, or shock, and will be unable to combat peripheral relaxation occurring in shock by increasing its output, since already the heart is overloaded and is using up its reserve force daily. A patient with slight *under*load, that is, where the pulse pressure is less than 50 per cent. of the diastolic, but more than 25 m.m. pressure, is usually a better risk for serious surgery than those with enormous overloads.

The diastolic pressure, in general, is a measure of *arteriolar* tonus, while the pulse pressure represents the strength of heart contractions; both are influenced by the heart rate and respiration rate.

The heart has two methods of varying its output of blood, namely, by changing its rate of contraction and by changing the amount of blood moved at a stroke. Clinically, it is generally observed that a rapid heart which has been preceded by a momentary fall in diastolic pressure, and which in spite of the rapid contractions, is unable to increase the total or systolic pressure, will exhibit a gradual decrease in pulse pressure, which is one of the cardinal signs of approaching shock.

To follow this typical case through to complete shock, the pulse pressure becomes progressively smaller and smaller, while the diastolic pressure also falls progressively, but often in such a ratio that the pulse pressure to diastolic pressure is less than one-half. When the pulse pressure has reached 20 m.m. or less, and is associated with a diastolic pressure of less than 80 in a patient, who, at the beginning of the operation had presented normal pressures, frank shock has occurred. If these low pressures are continued without improvement for more than half an hour, a vicious cycle is generally established, which, without adequate treatment will cause the death of the patient.

As the heart is fatigued by overwork, its muscle lengthens and with each subsequent contraction, fails to completely empty itself. With this dilitation and progressively falling pressures, the heart's own nourishment is reduced and is further embarrassed by the prolonged period of contraction—anemia from its rapid action. This reduced nourishment leads to further embarrassment thus forming the vicious cycle. The vicious cycle thus established may require hours or days to finally completely wear out the heart.

Ether and chloroform reduce the pulse pressure and may initiate shock by their action on the heart in reducing its output, thus disturbing the balance between the arterioles and the heart, followed sooner or later by an increase in pulse rate; while surgery through traction on organs, trauma to nerve trunks, irritation of large areas of peritoneum with gauze, or the loss of blood, usually disturbs the balance by causing peripheral dilitation almost invariably observed in the abdomen as the early appearance of marked congestion. After the balance has been disturbed at either end, both the arterioles and the heart participate in the further development of shock if the cause still continues.

There are so few conditions in which blood pressures increase during an operation, that the danger of hypertension developing on the table, I believe, may be generally eliminated. In my experience I have never seen a systolic pressure increase during

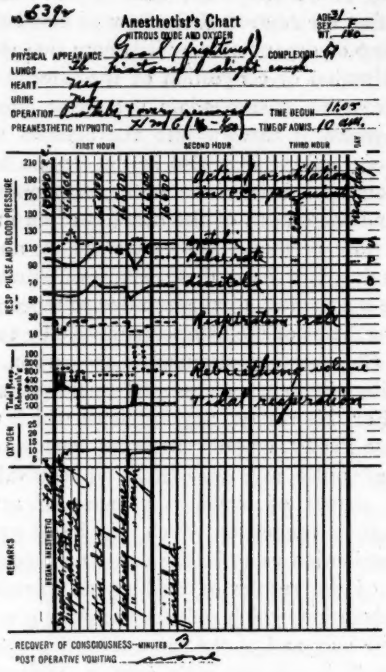
an operation more than a patient is able to increase blood pressure by straining at stool, which may be considered a normal, or a physiological rise. There is no anesthetic with which I am familiar, which will produce a rise in blood pressure after the first stage has passed, although nitrous oxid has been incorrectly so accused in much of the old literature. The greater the length of time and struggling in the first stage, the more frequently a rise occurs. It is, therefore, most commonly seen in the first stage of ether.

The influence of respiration on blood pressure during general anesthesia is due to a more or less obstructed airway, to the position of the patient on the table which may embarrass respiration, by the weight of the arms across the chest, if so placed, by leaning, assistants, or the Trendelenberg position.

Ordinarily, on inhalation, diastolic and systolic pressures are from 5 to 20 m.m. lower than on exhalation. When the obstruction in the airway produces marked snoring the variations may be greater, amounting to as much as 30 m.m. If the respirations are very rapid, however, respiratory variations in blood pressure are less marked.

On inhalation, blood is aspirated into the great veins, right heart, and pulmonary arteries, from all parts of the body; the pulmonary capilliaries are straightened out and dilated, allowing an increased flow of blood from the right ventricle, but delivering a decreased quantity of blood to the left auricle so that arterial pressure falls. On exhalation, this blood-saturated-lung is compressed by the air within, and the chest wall without, thus forcing an increased quantity of blood into the left heart and systematic circulation and elevating the pressure for two or three heart beats; at the same moment, the compression in the lungs has a tendency to dam back the blood from entering the thoracic cavity, and when the obstruction to respiration is marked, the result is an increased peripheral venous congestion, especially noticeable in the head and neck. If the lungs are *kept inflated under considerable pressure,* the pulse and diastolic pressures both fall, imperfect ventilation results, venous congestion or cyanosis immediately supervene. The pulmonary obstruction or capillary compression may cause right heart dilitation.

The respiratory variation in blood pressure is measured as follows: The pressure in the cuff is pumped above the systolic pressure; then as the pressure is gradually released we listen for the first clear pulse tone which occurs during exhalation. This is the *expiratory* systolic pressure. As the pressure in the cuff falls gradually we hear faint pulse tones during inhalation, but these are disregarded until they are of equal intensity to the one first noted in exhalation. When such a tone is heard the *inspiratory* systolic reading is made.



Case No. 5392 illustrates several things. In the first place the patient had too small a dose of morphin and hyoscin for her temperment and came to the operation thoroughly scared, breathing 30 times a minute, pulse on systolic pressure only 100, diastolic 58. The ventilation of 13000 c.c. per minute had so reduced the CO_2 that the patient was already on the way to shock before the operation had begun, and this tendency was further increased for the first 15 minutes, but by rebreathing 400 c.c. of each breath, beginning this large rebreathing on the 10 minute line, the heart rate became slower progressively, while the blood pressures increased to their normal by the end of the operation. This patient actually left the table in better condition than when she came on, and remained so, as shown by the pulse and pressures at 2 o'clock and again the next day.

The notch in the diastolic pressure was caused by rough handling in exploring the abdomen at the 45 minute line. It was followed immediately by a fall in the systolic pressure and a rise in the pulse rate but as soon as the cause was discontinued, the pulse and pressures began to recover, showing that the shock-producing-influence had not been so prolonged as to exhaust the cardio-arteriole musculature.

The difference between the inspiratory and expiratory readings is the respiratory influence on systolic blood pressure. Inspiratory and expiratory diastolic pressures are obtained in the same manner.

From clinical observation in taking these pressures, it appears that in obese patients, in whom the airway at the base of the tongue is kept free by means of a pharyngeal tube, that the weight of the chest wall in some way obstructs exhalation, possibly by collapsing the smaller branches of the

bronchial tree, and thus interfering with the pulmonary circulation, dams back the blood and produces venous congestion and cyanosis.

The accompanying chart serves to illustrate some common clinical observations of blood pressure, pulse, and respiration during major operations.

2233 ASHLAND AVENUE.

DISCUSSION.

DR. MONTFORT, Chicago: The anesthetist and surgeon should take into consideration the favorable action of H. M. C. previous to giving the anesthetic. I have had opportunity to see H. M. C. used by W. F. Waugh, the originator of that form of anesthetic and know what effect H. M. C. has on blood pressure and in the prophylaxis of shock.

DR. JAMES T. GWATHEMY: I think this is a very important paper. Blood pressure is something that very few of us know anything about from a practical standpoint. If everything Dr. McKesson says is true, then all anesthetists should study blood pressure in relation to anesthesia. He has stated that shock would be indicated by the blood pressure at least fifteen minutes before any clinical sign. If that is so, it would be almost criminal to neglect to take the blood pressure. I would like to have Dr. McKesson bring out in his closing remarks exactly how he has determined this time warning in regard to shock.

DR. F. D. BULLARD, Los Angeles: I would like to have the doctor bring out a little more the question as to the influence of the Trendelenburg's position. I frequently have requested my surgeons not to use that position for any prolonged time. I have noticed that prolonged Trendelenburg position is very deleterious to the patient.

DR. MARY E. BOTSFORD, San Francisco: I feel that I am not in position to discuss this paper, because unfortunately I never availed myself of this great advantage, which it certainly must be. I should think it would be a very wise thing to have it adopted as part of the ordinary method of anesthesia. Ordinarily the anesthetist is obliged to be keen enough to discover symptoms of shock more than fifteen minutes before it occurs. I would like to ask the doctor what in his opinion is the factor which most of all produces this rather sudden drop in blood pressure as shown in one of his charts. I should also like to say that I agree with him that it is many times produced by an inefficient assistant.

DR. J. E. ENGSTAD: Have you noticed a sudden drop of pulse pressure in changing from the Trendelenburg to normal and normal to the Trendelenburg positions? Surgeons say it is dangerous to change from the Trendelenburg position to the horizontal quickly, that you should allow a half minute for the change.

DR. E. I. MCKESSON, closing: In regard to the use of the H. M. C. tablet, of course, it would take a very large number of charts of practically uniform kinds of operation and uniform patients, to show any change between those patients with H. M. C. and those without. I have not made a careful study of such a series, so what I would say would be an impression, and not based on real observations. My impression is, that H. M. C., or morphin and hyoscin, previous to operation, say one and a half to two hours before, administered in proper dosage, sustains blood pressure rather than acts as a depressant.

The interpretation of the blood pressure picture brought up by Dr. Gwathmey as a sign of approaching shock prior to the time that we are able to detect it by feeling the pulse is a little complicated. It involves the rate of the pulse and the ratio between the pulse pressure and the diastolic pressure so that it is a *composite* picture. To say that the lessening of pulse pressure indicates that your patient is going into shock may not be correct, because the blood pressure may be brought up adequately as a compensatory effect, by an increase in pulse rate. Again, to say that because your pulse rate is maintained, that the patient is *not* approaching shock would be just as erroneous, because if you take the blood pressures you may find the systolic or diastolic pressures coming down, which is evidence sufficient that when these pressures decrease more than ten per cent. your patient is *approaching* shock. You can extend the pulse, diastolic and systolic curves on the chart and, allowing for surgical work, locate a future time on the chart at which the pressures are low enough to institute shock and the shock cycle in the heart. The length of time that you can anticipate the development of shock by this method varies from fifteen to forty-five minutes. Some patients have a great deal of reserve power—to use the slang of the day, a good deal of "pep"—a great deal of strength to come back, while another person who has been exhausted by cardiac over-work, the blood pressure picture may show that the heart has been exhausted or nearly exhausted up to the time of operation. That patient will develop shock more rapidly. So, reserve power must be considered in giving a prognosis.

As to the Trendelenburg position, I would not advise it for long periods, especially with the surgery it accompanies, for your patient soon develops more or less shock, and very often *more* than *less*. Personally, I will not put a patient in an extreme Trendelenburg position for anybody. (Applause)

What factor produces the sharp drop in blood pressure? In the chart shown it was due to a ligature slipping off the renal artery. But the thing that is common, that you and I see every day, is this pulling and hauling and rough handling. You talk to the surgeon and he will say: "I believe in handling the tissues gently," but at the same time he may be pulling. He does not seem to realize that he is doing anything to cause his patient shock and the only way you can convince him is to show him chart after chart where, when he begins to pull or uses large abdominal packs, his patient develops shock.

In regard to changing quickly from the one position to another affecting the blood pressure, blood pressure does not make the change as quickly as that, unless your patient is deeply anesthetized, then any change of position will produce a corresponding change of blood pressure. But if your patient has an approximately normal tonus, the cardiovascular system has the power to accommodate itself, and the change from the Trendelenburg to a horizontal position will not cause immediate change in pressure. The change will commence probably during the following five or ten minutes.

ETHER AS AN ANTIDOTE FOR COCAIN AND NOVOCAIN POISONING.*

J. E. ENGSTAD, M.D.,
MINNEAPOLIS, MINN.

In the year 1910 I published an article in the Journal of the A. M. A. under this title, *Ether an Antidote of Cocaine and Novocaine*, giving the history of a few cases and a résumé of what was known of the action of ether and cocain on the human system, both in large and in small doses.

Since that time my clinical experience has been further enlarged by having the opportunity to test the action of ether in a large number of cases of poisoning from the alkaloid of cocoa leaves.

In addition, from time to time, cases have been reported which all tend to confirm my earlier claims for ether as a safe, and in the majority of cases, certain antidote for the subtle and dangerous alkaloid cocain as well as any of the synthetical preparations, whose properties and chemical combination are allied to cocain.

* Read during the Third Annual Meeting of the American Association of Anesthetists, in San Francisco, June 21, 1915.

Cocain lowers the blood pressure with a tendency to inhibit the complete systolic action of the heart, especially of the right side. It also inhibits the respiratory action due to poisoning of the respiratory centers of the brain; the heart becomes flabby and there may be an over stimulation of the excelerator nerves.

When the right side of the heart does not synchronize either in systole or diastole, this form of heart block, in cases of cocain poisoning, may be due to anesthetizing of the bundle of His, by the direct action of the drug circulating in the blood.

Ether is a rapidly acting diffusible cardiac stimulant; it stimulates the vaso-motor as well as the respiratory centers; it increases the blood pressure and has apparently a special affinity for the toxic elements of the diffusible alkaloids. If this affinity is due to the ether molecule entering the cells of the central nervous system, neutralizing the toxic action of cocain, or desensitizing the active principle of the drug, or if it changes the toxic molecule into a less harmful combination to the animal organism, it is still unknown.

Dr. Corbit of the University of Minnesota, has conducted a number of experiments with novocain, by injecting this drug directly into the veins of animals, and he has experimently confirmed what was clinically known for a number of years, that ether is a safe and efficient antidote for the alkaloid cocain and any synthetical preparation, allied in action. He reports: *"I find that the injection of solutions. of novocain directly into the veins in unanesthetized animals frequently produces toxic symptoms, manifested by tetanic spasm of the voluntary muscles of the back, and marked respiratory embarrassment. I have found that a fatal outcome in these cases could be prevented by the administration of ether.*

"While this is a matter that has been developed by you in a clinical way, I feel that very tittle has been done in experimental work, and possibly this may aid you in the propaganda for the prevention of death from novocain poisoning. In addition, I want to say that I am very much pleased that you are taking this matter up and are again popularizing it."

Clinically there are a large number of cases which have come under my observation and under the observation of other surgeons who have resorted to the use of this article in accidental poisoning.

When cocain was first brought to the attention of the medical profession, its poisonous character was not recognized until a large number of deaths had been reported, and it is doubtful if half of the accident cases due to its indiscriminate use were ever heard of. I had practiced medicine a number of years when cocain was first brought to the attention of the profession and was being hailed as a *cure-all,* free from danger.

Its toll of life would have been enormous had it not been for the exorbitant price which prevented its extensive use until its dangerous properties were brought to the attention of the public. Its reckless use, especially by the dentists, gave me an extended experience in cases of poisoning from this drug. One dentist called me repeatedly to his office on the same floor, to resuscitate cases of poisoning from cocain used to minimize pain in the extraction of teeth. This dentist, in common with so many of this period, disregarded all my warnings of its danger, ascribing the peculiar nervous disturbances of its action to hysteria.

In the first few cases I was called on to treat, strychnin and morphin in combination were used with marked benefit. But as cases kept multiplying, I found the action of these drugs too slow, and I decided that there must be something to counteract the poison more rapidly when life was in extreme danger. It was necessary to find a remedy that could be administered at any time and be instantaneous in its action. After a little experimentation, I soon found ether to be the required drug. This was administered as ordinarily given to produce surgical narcosis; that is, to the stage of stimulation of the vaso-motor system and of the respiratory centers, of the brain and of the pneumogastric nerve which increases the pulmonary circulation in the first stages. We know that cocain inhibits the action of the heart, especially on the right side, and it has a marked inhibitory action on the respiratory centers of the brain, and death may occur from feeble respiratory movements of the so-called Cheyne-Stokes type, or asphyxia.

To me ether has proved extremely valuable in what seemed hopeless cases of cocain poisoning. It stimulates the heart and the respiratory system almost instantly and the pulse becomes fuller at once and of normal tension. The marked mental excitement is allayed as the patient goes under the influence of the ether and the effect of the poison rapidly disappears. The individual regains consciousness as soon as the effect of the small amount of ether has disappeared if its administration only is carried to the stage of analgesia.

To get the best results, the anesthetic is administered only to the degree of mild surgical analgesia, or at times, even less than this. A mask should be employed and the ether given by the drop method. This is all-important. Given by the old

method the ether would only add to the danger of asphyxia by excluding air from the lungs engorged with venous blood.

My last case, a typical cocain poisoning, was the patient of a very conservative and capable oculist, who had instilled a few drops of a 2 per cent. cocain solution in an eye for obtunding the lachrymal duct previous to its dilitation, and, as the duct was pervious, part of the solution had evidently entered the nasal mucus membrane and been rapidly absorbed.

The patient, a girl aged twelve, exhibited symptoms of extreme restlessness complicated with dyspnea, with respiratory movements of about 40, the respiration generally intercostal, with an occasional diaphramic sighing inspiration. There was a peculiar pallor of the face, eyes large and pupils dilated, and a persistent restlessness and extreme anxiety which is characteristic in this form of poisoning. The pulse was barely perceptible. Ether had been brought, and the confidence I had in its action and potency tempted me to remark that the child's third or fourth respiratory movement after the first whiffs of ether would be normal ones, and that her recovery would be almost instantaneous. True to my prediction, the fourth respiration was normal and almost immediately the respiratory movements became entirely natural, and pulse regained its tension, the mind became clear and calm, and the anxious expression gave way to one of well being and peace.

SYNDICATE BUILDING.

DISCUSSION.

DR. CARL G. PARSONS, Denver, Colorado: I have been indebted to Dr. Engstad for a number of years, ever since reading his article in 1910 on the subject of an antidote for novocain and cocain, especially in spinal anesthesia. I have had collapses in several cases where I have given spinal anesthesia, and almost immediately a few whiffs of ether would bring the patient around.

A member at the meeting of the Western Surgical and Gynecological Association told of a physician who was working at the laboratories at the university, and his wife was in the dental chair. He got a telephone that she had collapsed under an injection of cocain into the gum. The amount was not large, so it was a real case of cocain poisoning. This doctor said there must be some way of giving an antidote in these cases, and I told him of ether and he was very glad to know it.

When a man like Dr. Engstad has solved a problem that he has been working on for fifteen years he ought to have recognition for his results, and his treatment should be known as *Engstad's Method.*

DR. JAMES T. GWATHMEY: I would like to ask how the doctor gives the ether. I suppose by the drop method?

DR. J. E. ENGSTAD: I give it on a mask so the patient can get the air mixed with ether. We must not exclude air, because the patient is really suffering from asphyxia. The method is just a few drops on the mask. The quantity, sometimes twenty or thirty drops. I doubt if I have ever administered four grams. Just two or three shakes of the ether bottle on the mask and the patient will revive and we have no further need for stimulants.

DR. GEORGE W. KENNEDY, Sharon, Pennsylvania: What is the physiology of the antidote?

DR. J. E. ENGSTAD: I will read from the paper:

"It increases the blood pressure and has apparently a special affinity for the toxic elements of the diffusible alkaloids. If this affinity is due to the ether molecule entering the cells of the central nervous system, neutralizing the toxic action of cocain, by desensitizing the active principle of the drug; or if it changes the toxic molecule into a less harmful combination to the animal organism, is still unknown."

THE RELATION OF VENTRICULAR FIBRILLATION TO CLINICAL CHLOROFORM SYNCOPE.*

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Since McWilliam in a British Medical Journal of 1889 drew attention to ventricular fibrillation as a form of sudden circulatory failure and death, very little had been written upon the subject until Dr. Goodman Levy published his first communication in a Journal of Physiology of 1911 upon its relation with chloroform and adrenalin. Since that time Levy has contributed more valuable data of great interest upon the subject.

It is a circumstance of much significance that those experimental physiologists who have worked with dogs in the elucidation of clinical problems, should have reported no observation upon the occurrence of ventricular fibrillation. Nor is this owing to any experimental difficulties in eliciting the phenomen nor of interpreting it when it has happened, since it is readily recognizable and may be frequently observed in the laboratory when cats are used for experimentation under chloroform. I have found it to occur during the administration of chloroform to three out of five successive cats, whilst out of several hundred successive dogs in which death had been caused designedly by chloroform under a great variety of conditions, I have never observed it except as a terminal process when the blood pressure had fallen very low from shock or some other cause—quite a distinct event from that form of fatal syncope in cats.

There is no doubt as to the occurrence of ventricular fibrillation in cats during the administration of chloroform. There is also no doubt about the absence or infreqnency of its occurrence under chloroform in dogs. Owing to this circumstance the employment of data obtained from cats in this relation ought to be very guarded in the interpretation of clinical phenomena.

Levy, however, contends that the analogy between this form of death in the cat and the clinical form of chloroform syncope is so close as to war-

* Read during the Third Annual Meeting of the American Association of Anesthetists, San Francisco, June 21, 1915.

rant the assumption of a common causation—ventricular fibrillation. McWilliam qualifies a like assumption.

Both McWilliam and Levy refer to the frequency of occurrence of syncope in cats due to ventricular fibrillation, both during induction and reinduction of chloroform anesthesia. McWilliam more than Levy finds it occur at *any* period during chloroform anesthesia. McWilliam, however, contends for an abnormal condition of the circulation, as a necessary factor accompanying that of chloroform. This does not appear to have been Levy's experience and it certainly has not been mine. Levy has extensively investigated the conditions supplementing the chloroform factor.

A characteristic of the circulatory apparatus of the cat is the readiness with which changes occur in the cardiac rhythm under the reflex influence of the various forms of afferent nervous impulse. Vagus impulses are inhibited and those of the accelerator mechanism substituted, the normal rhythm of 120 or so beats suddenly changing to one of 350 or so beats to the minute. When the sensory impulses arise from the mucous membrane of the respiratory tract, as when weak ammonia, oil of mustard or chloroform vapour is inspired, a marked difference is noticeable in the regularity of the heart's rhythm between that occasioned by chloroform and that of the other substances. The accelerator rhythm with chloroform is markedly intermittent, whereas that with ammonia and other irritants is practically free from intermissions. This intermittent feature is a very important peculiarity of the chloroform action. It ocurs before anesthesia sets in, and during its period of incidence ventricular fibrillation may occur. The intermissions appear to be due in part to the temporary periods of ventricular fibrillation and part of the temporary return of vagus innervation arising as a consequence of exaltation of the excitability of this nerve by the chloroform. The latter irregularity is cut out by atropine. If, however, during the period of irregular cardiac action, ventricular fibrillation does not set in, narcosis deepens and anesthesia comes on. With the onset of anesthesia the afferent impulses cease. This circumstance together with the exaltation of vagus excitability by the chloroform, restores the vagus control of the heart rhythm. The restoration of vagus rhythm is indicated usually by the sudden change from the rapid accelerator to the normal or slower rhythm. Fibrillation does not now occur. The tonic systolic contractions of the vagal rhythm has a decided influence in checking incoordinate ventricular muscle contraction. There is uniformity in the experimental observations on this point.

This series of events occurs again and again in reinductions of chloroform anesthesia. The excitability of the vagi of the cat does not become depressed by the chloroform anesthesia as happens with the dog under the same circumstances. This doubtless is due to the excitability of this mechanism in the dog being raised to great activity by induction, whilst on the other hand the degree of exalted excitability in the cat is relatively feeble.

It is to the fact that ventricular fibrillation occurs only in the pre-anesthetic stage in cats that Levy has been led to assert that the danger from chloroform lies in the induction of anesthesia by what has hitherto been regarded as concentrations within the limits of safety.

There is a striking discordancy between this picture of the induction of chloroform anesthesia in the cat and that under the same conditions in the dog. Some intermissions occur during the pre-anesthetic struggling of the dog. This is preventable by atropine or vagotomy. There appear to be no temporary onsets of ventricular fibrillation. If prolonged or permanent inhibition of the heart sets in, it occurs at the end of induction, or in the case of the morphinised dog, somewhat later. This is a common occurrence and one of the most striking phenomena of chloroform narcosis in the dog. The syncope of the dog from chloroform appears to be of the vagal type only. It is not easy to kill a vagotomised dog with chloroform.

The syncope of the dog is not merely due to inhibition of the heart by the vagi. The vaso-constrictor mechanism is coordinately inhibited. This form of syncope arises from a high tension of chloroform in the arterial blood, exalting the excitability of the vagus and vaso-motor mechanisms, and at the same time depressing that of the myocardium.

It is probable that no clinical fatalities arise as a consequence of a general high tension of chloroform throughout the entire blood mass and tissues of the body. Such a tension is brought about relatively slowly, consequently the progress of general circulatory and medullary depression is relatively slow. Further accessions to the tension of the chloroform in the blood are prevented by failure of respiration. Thereupon artificial respiration lowers the tension of chloroform in the system to a level consistent with respiratory activity. There is always plenty of warning of the oncoming depression.

Syncope from cardio-vascular inhibition is the result of the intake of excessive concentrations of

chloroform vapour during normal breathing or to excessive inspirations of concentrations not otherwise too high. It does not occur in the normal breathing of concentrations within the 2 per cent. limit. Over this it occurs with a frequency which increases with the increase of the concentration. The probability of recovery from this cardio-vascular form of syncope depends upon the degree of myocardial depression which the dog's heart has suffered before the incidence of inhibition. It is essentially the result of overdose.

With regard to overdose, Levy appears to have failed to recognize the distinction between an excessive tension of chloroform in the arterial blood and an excessive tension throughout the entire blood mass and tissues of the body as above described. The sudden rise of tension of chloroform in the arterial blood from excessive intake by breathing is similar to that which results from the injection of three drops of chloroform (diluted) into the external jugular vein in continuity. Such a dog dies or very nearly dies and from overdose. Hence Levy errs in contending that cases of early syncope cannot be due to overdose, and his interpretations of 76 clinical fatalities from chloroform as stated in the Proceedings The Royal Society of Medicine, 1914, Section vii., are fallacious accordingly.

My own experiments with cats indicate that fully established ventricular fibrillation is fatal. Neither heart massage nor any other measure appeared to have any effect upon it. Short periods of imperfect fibrillation recovered spontaneously. I cannot comment on McWilliams' case of recovery after an hour of heart massage and the use of pilocarpine.

Whether centricular fibrillation or cardio-vascular inhibition is the cause of clinical chloroform syncope must rest with that form, the analogies of which to the clinical syncope offer the greater approximation.

The respective analogies are set forth as follows:

(1) Syncope of cardio-vascular inhibition occurs in dogs only in the period of induction. This also is the period of incidence of clinical chloroform syncope. Ventricular fibrillation may occur at any time during the course of prolonged administration during reinduction after temporary recovery.

(2) Cardio-vascular syncope in the dog is frequently recovered from by artificial respiration alone or together with heart massage. This coincides with the recovery from syncope in clinical instances. In my experience established syncope from ventricular fibrillation is not recovered from, or if recovery occurs, it must be very rare.

(3) The control of the cardiac rhythm in the dog is markedly vagal and it approximates in this respect to that of the human. In the cat on the other hand well marked vagal control is not characteristic and vagal control as prevails is readily inhibited. A heart under vagus control is not prone to ventricular fibrillation. Hence the .t's heart should be more prone to ventricular fibrillation than that of the dog.

(4) Reflex syncope from cardio-vascular inhibition in dogs may occur as readily as the reflex syncope from ventricular fibrillation in cats.

(5) Syncopal states occur clinically either reflexly or from overdosage in which the heart does not stop, but becomes very slow, resembling similar states occurring in the dog from the effects of chloroform, and correctable by vagotomy.

This statement appears to me to show a balance of probability in favour of cardio-vascular inhibition as being the cause of clinical chloroform syncope.

Under these circumstances Levy's contention that *"the exercise of care against overdosage in the administration of chloroform is wrong,"* must be regarded as unwarranted by the evidence and as a dangerous and unreasonable teaching.

"THE THORNBURY," LA TROBE STREET.

DISCUSSION.

DR. JAMES T. GWATHMEY, New York City: I believe that the unreasonable prejudice that exists against chloroform in a great many quarters is due to the fact that the laboratory findings in regard to chloroform have been made by men who are not practical anesthetists. They have been made by laboratory workers who do not understand the finer points of anesthesia, and in explaining the figures as I have seen them explained by men prominent in the physiological field, it seems to me that we must study their findings with a great deal of caution. The Germans have proven beyond question that if chloroform and oxygen and air is given by the Roth-Drager apparatus, with the chloroform, oxygen and air measured by volume, the patient suffers no toxic effects, but comes out, as from a nitrous oxid-oxygen anestheia in a perfectly clear state of mind. As determined by measures taken to ascertain toxicity, patients are just as safe with chloroform under these conditions as any anesthetic. The blood pressure is maintained perfectly and shock does not occur any more rapidly with chloroform as given in this way than under local anesthesia.

In regard to sudden cardiac inhibition, I think there is no question that it would occur in certain conditions, but I think very few of us would have the temerity to give chloroform unless the patient had been previously given morphin or atropin. But if these things have been attended to, anesthesia with chloroform is perfectly safe and justifiable, provided we know that over-concentration must be guarded against. In giving chloroform, as I have given it in several thousand cases without any fear and with absolute assurance, I have always had in mind the fact that after delivering one to five drops upon the mask, this amount must be taken into the system diluted with air, waiting one or two minutes at least before the dose is repeated, and in that way I avoid giving over two per cent. of chloroform. Then when patients go into the second stage of anesthesia switch to ether, and we have a perfectly safe sequence; just as safe as the nitrous oxid and ether sequence. It seems to me that if we as a society are, as suggested by Dr. Bullard, to give our voice of approval or disapproval to some form of anesthesia, we should say that the gas and ether sequence should be a thing of the

past. I know of one or two deaths in New York that have occurred under gas-ether. It should be gas-oxygen-ether. The same way with chloroform. With proper chloroform anesthesia, if we are careful during the first five minutes, we will have no trouble, but we must observe the proper dosage and pay strict attention to details of administration.

It is unfortunate that there is no center here in the United States in which this form of administering chloroform clinically obtains. If we do not give chloroform as it should be given, results are bad; but it should be given with known percentages of oxygen and air.

DR. J. E. ENGSTAD, Minneapolis: I believe it was Babcock of Chicago who brought out the theory that in cases of sudden fatallities following any poisoning by chloroform, or ether, or novocain, death is due to the action of the bundle of His in the heart, which causes heart block. It is not due to the reflex centers, or the respiratory centers, but particularly to the nervous center of the heart, the bundle of His.

STATUS LYMPHATICUS IN RELATION TO GENERAL ANESTHESIA.*

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Our absolute knowledge of the condition called *Status Lymphaticus* is very small, but I think the type of patient suspected of this condition has become better defined in the minds of diagnosticians. My intimate acquaintance with status lymphaticus dates from an operation performed in July of 1912 for removal of tonsils and adenoids. This case I will discuss later.

The problem is a previous diagnosis and not an autopsy diagnosis of these so-called cases of status lymphaticus. The predominant view of pathologists is that the lymphatic hyperplasia has nothing to do with the mechanism of the sudden death, but is only a mark of some pre-existing abnormal constitution in which the vital organs are immediately and fatally deranged by quite trivial causes. So pathologists have adopted the doctrine of a subtle constitutional change in the various cells of the body which remains concealed until the catastrophe takes place. Other theories are that the enlarged thymus acts mechanically on the trachea, interferes with the vagus nerve or excites reflex spasm of the glottis. Again, that toxins produced by the thymus cause cardiac paralysis.

Diagnosis of a Patient Suspected of Status Lymphaticus: In the male there are feminine characteristics, pale, smooth, soft, delicate texture of skin; an abundant amount of subcutaneous fat; extremities well-formed and rounded, hair scanty on all parts of body. In the female there are male characteristics: deep base voice, hair on face, narrow chest and hips. Nearly all are blondes. In children there is more or less dyspnea, a typical adenoid expression, pale, with thick, large, short and stocky neck; and flabby fat. Palpitation of the thymus is difficult, as the glands of the neck are often enlarged, but if on percussion one finds an area of impaired resonance over the manubrium sterni, an *x*-ray may confirm a diagnosis of enlarged thymus, but always keep in mind enlarged deep cervical glands.

Knowledge of the thymus is limited. That it has an internal secretion is certain, for experiments on animals of removal of the gland soon after birth leads to changes resembling rickets. The size of the gland is indefinite, many think it increases in size and weight up to about the age of fifteen, after which time it normally undergoes gradual involution. The normal weight during infancy is from ten to twenty grams, and at puberty may increase to forty grams.

Most of the cases reported when death has occurred early in an operation were cases where chloroform or like anesthetics were used, and showed cardiac failure first, followed by respiratory failure afterwards. While those cases when ether was used died towards the end or after the operation and showed respiratory failure first and cardiac failure afterward.

Lymphatic cases are difficult to anesthetize, hard to keep quiet; the throat is full of adenoid tissue making breathing difficult; the tongue is thick and neck short and stocky. They are a poor risk and avoid operation if possible. If an anesthetic is to be given use the lightest, shortest anesthetic and urge rapid work. Nitrous oxid-oxygen anesthesia is to be preferred, while nitrous oxide-ether by the vapor method may be used for tonsil and adenoid work at no time producing too deep anesthesia.

REPORT OF CASE.

Girl, aged 5, blonde, well nourished, stocky, adenoid type of face. Examination: large tonsils and adenoids; heart and lungs negative. I gave an ether vapor anesthetic. She became cyanotic; we judged on account of her throat being full of adenoid tissue, for after the removal of one tonsil her breathing and color improved and the operation continued and finished in a few minutes with an uneventful recovery. Two weeks later the child had an attack of dyspnea, became cyanotic and died in ten minutes of heart failure. An autopsy was held with the typical status lymphaticus picture, which consisted of a hyperplasia of the thymus and lymphatic glands of the body. The weight of the thymus was 75 grams. There was also edema of the lungs.

DISCUSSION.

DR. MARY E. BOTSFORD, San Francisco: I had an opportunity at one time of anesthetizing in succession five children in whom the diagnosis had been previously made by Dr. Moffit of San Francisco. The children were of rather

* Read during the Third Annual Meeting of the American Association of Anesthetists, in San Francisco, June 21, 1915.

a better type than those in whom status lymphaticus is usually found. They were anesthetized by gas oxygen as a preliminary, with ether by the vapor method. There was no serious condition afterwards. It may have been an accident that no fatality was recorded in the series.

DR. F. D. BULLARD, Los Angeles: I have been called twice by the coroner of Los Angeles to be present at the autopsy in cases of status lymphaticus. In each case the operation was for removal of adenoids and tonsils. We found a very large thymus gland and in each case chloroform had been used. I think Dr. Roberts, of Pasadena, said there were about twelve cases in southern California of deaths from the adenoid and tonsil operation, and all following chloroform. So under no conditions would I give chloroform for a tonsillary operation. Very few people in our section will do so now. The method that I think is best, if you have not nitrous oxid, is to give the ether by the "Rausch" method and using warm ether. I have never seen ether given in this way that was over ninety seconds in getting results. I suppose you are all aware you can put anybody to sleep in ninety seconds if the ether is warm. I know the blood pressure is increased, but I have handled a number of cases of status lymphaticus by warm ether. The "Ether Rausch" was discovered by a German a few years ago. We Americans had used it for twenty years before. I began to give anesthetics in 1892 and gave it then. Down in Southern California we passed a resolution that we never would allow anybody to give chloroform for the tonsil and adenoid operations. I should like to see this Association do something of that kind.

DR. MARY T. MURPHY, San Francisco: I would like to ask Dr. Roberts if the patients she has seen have had nitrous oxid as a preliminary to the anesthesia. I think we should lay a great deal of stress on that, particularly with children. I have rather an extensive practice with children, and in using nitrous oxid unconsciousness is gained so rapidly, the secretions are lessened, the anesthesia is very much quieter and smoother, and the element of fear is done away with, and I think so much, in a case of status lymphaticus, depends upon the fear in the mind of the child.

DR. JAMES T. GWATHMEY, New York City: I think it is Doctor Skeel of Philadelphia who has reported over 5,000 cases of adenoid and tonsil operation with chloroform, with no bad results whatever. It seems to me it would be wrong for this society to pass any such resolution as is suggested. I do not think the anesthetic has so much to do with the fact of death as the way it is administered. As the last speaker has said, in cases of status lymphaticus the question of fright comes up very prominently, and if we can eliminate fright it does not make any difference what the anesthetic is, provided, of course, that the anesthesia is not too deep or prolonged. Of course, I know the general consensus of opinion is that chloroform is contraindicated in these cases, but I do not think any anesthetist would use chloroform if the case was diagnosed as status lmphaticus. At the same time there might be certain other elements that might come up; it seems to me it would be very much better to use chloroform rather than nitrous oxid in the presence of existing cyanosis. Status lymphaticus as a rule is diagnosed after death and not before, and I think it has quite often been taken as an excuse for improper and unnecessary dosage of anesthetic, or poor methods of administration. rather than as the real causative factor of fatalities. Death has followed the use of nitrous oxid in cases that have been diagnosed as status lymphaticus, as well as chloroform or ether, so nitrous oxid is not a prophylactic. The principal thing is to do away with the element of fear in some way.

DR. CHARLES K. TETER, Cleveland, Ohio: Personally, I have never seen a case of status lymphaticus, and I should have run across them in administering anesthetics. I have had over 6,000 children, but have never had a fatal case; and over 13,000 anesthetics for major surgery, with only one fatal case, and that was not status lymphaticus. In addition to that, 19,000 for dental surgery, without a single fatal case. So I have noticed that status lymphaticus occurs where they have a good many anesthetic deaths. As a rule the anesthetist gets the blame, and I am glad the anesthetist can blame status lymphaticus.

DR. J. MARGARET ROBERTS, (closing): I have nothing further to add except that I have seen one or two cases where the patient had a full stomach—but the patient died of status lymphaticus.

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THE ESSENTIALS OF ANESTHESIA FROM THE STANDPOINT OF THE OPERATOR.*

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It is with a certain timidity that I venture before this society to put forth some ideas regarding a very hackneyed subject, "The Essentials of Anesthesia from the Standpoint of the Operator," because I can perhaps do nothing more than present some old ideas from a new angle.

If we consider the status of surgery in general at the time of the discovery of the anesthetic properties of ether, we at once note that at that time the limitations of operative surgery were so marked and the risks of death from sepsis so great, that one thing only was required of an anesthetic—*the abolition of pain during the performance of an operation.* In a relative sense the risk of the anesthetic was nil. Neither the delicate manipulations of brain surgery, the extensive exploration of the abdominal cavity, nor the specialized types of the surgery of the thorax were dreamed of, and the minute balancing of risks which we consider imperative at present were then not thought of.

With the abolition of infection and the invasion of the serous cavities of the body without septic risk, there arose considerations aside from the mitigation of suffering and, while that stands perhaps as the first essential of anesthesia to-day, it is also demanded of it that *the risk of life shall be negligible; that it shall be produced comfortably and conveniently; that post-anesthetic discomfort shall be trivial; and that the anesthetized patient shall be in such condition that the proposed surgical procedure may be carried out quickly, safely, and without other injury to the tissues than that which* is *inherent in the operation to be performed.*

It is needless to point out to this body that the anesthetic properties of nitrous oxid, ether, and chloroform were all discovered or proven within a comparatively short time of each other, and that chloroform rapidly gained its place as the anesthetic

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of choice because it was perfect in its abolition of pain, was rapid in its action, and was not too dangerous for the position which an anesthetic then occupied. An occasional fatality occurred, to be sure, but that was accepted as inevitable, and the infrequent catastrophe was lost sight of in the midst of the relatively greater disasters of sepsis, and, moreover, *any* agent which abolished the horrible pain of an amputation or a lithotomy was such a God-send that the risks of its use were hardly to be considered. As true surgical deaths became fewer in spite of the invasion of cavities previously held to be sacred, the occasional chloroform death became a very distinct factor in surgical mortality, and when finally its destructive action on the liver cells was demonstrated, it became evident that its gross mortality was too great to allow it to remain as the anesthetic of choice under all circumstances.

The exact mortality for chloroform anesthesia is unknown. As I write these lines the very practical, but somewhat dogmatic, paper of Dr. Bevan is brought to my attention giving the mortality rate for chloroform as being from 1-1000 to 1-3000, but owing to factors with which this body is familiar, it is obvious that there is no place in which the statistics of mortality are more unreliable than in those of anesthesia, and mortality statistics in general are about as unreliable as anything well can be.

I think, however, all will agree that chloroform danger is a real one, and without putting it in figures, one feels that it is too distinct to allow of its use under any other than exceptional circumstances. My own feelings regarding chloroform is such, that if it must be given and a man with wide chloroform experience is not available, I give it myself until the patient is completely under and operate with one eye on the anesthetic from that time on. The average interne, accustomed to the use of ether, with a chloroform bottle in his hand is about as dangerous an individual as can well be imagined.

Because of the extremely narrow margin between chloroform anesthesia and chloroform death, ether gradually superseded chloroform among those surgeons who operated upon a sufficiently large number of patients to be able to appreciate the relative safety of the one and the relative danger of the other, but so soon as the use of ether became popular it also was found to have some serious drawbacks. As given with a closed mask during my anesthetic days, it terrified every patient with its nasty, irritating odor and the sense of impending suffocation which it produced, but death on the table was extremely rare. As administered at present after preliminary nitrous oxid or with the open cone or as warm ether vapor, or even by one of the closed methods if the patient is not strangled, it is not so unpleasant and terror and struggling are not often in evidence.

It irritates the respiratory mucosa, however, causes increased secretion from the nose, throat, and bronchial tubes, and the inhaled mucous and saliva, or the diminution in resistance to infection for which the irritation is responsible, or some factor with which we are not wholly conversant, leads to post-operative respiratory complications more often than is satisfactory. Again statistics are of no value, but the impressions which one gains after years of almost daily use are a far better guide, and if my own impressions are of any value, I am sure that the post-operative respiratory complications of ether are its most serious drawback. Its effect upon the kidneys, too, must be taken into consideration. In my own experience there have been two cases of post-operative nephritis with total suppression of urine which could be laid to nothing else than ether. Then again the ether vomiting has not, and apparently can not, be abolished. Washing out the stomach, olive oil in quantities, and saline infusions, all tend to minimize nausea, but a certain proportion of ether nausea is central just as a certain proportion of alcoholic nausea is central, and up to the present no method of doing away with this has been devised; nor does there seem to be any way of avoiding that which I can only call *ether retention,* in which a patient after either a short or long anesthesia carries the ether odor on the breath for two or three days and vomits until that odor disappears.

Ether then filled the one essential of being practically without danger on the table, but it had elements of danger later and its discomforts could not be wholly abolished. It is no wonder that surgeons and anesthetists were casting about for a method of anesthesia which would lack the immediate risks of chloroform and the discomfort and remote risks of ether, but it is strange indeed that until very recently so little effort was made to ascertain the value of nitrous oxid in this respect. Desultory attempts at its use were made now and then, but nothing systematic was done in spite of the fact that Andrews, in 1868, demonstrated the possibility of prolonged anesthesia by the combined use of nitrous oxid and oxygen.

Geographically speaking, I believe that to Cleveland belongs the credit for the introduction of the *systematic* use of nitrous oxid—oxygen—for anesthesia for general surgical procedures, but curiously enough, the first men to use it have been overlooked.

During the winter of 1902-3, Dr. N. Stone Scott, then one of Cleveland's younger and most active

surgeons, induced his brother-in-law, Dr. Ernest E. Brown (now deceased) to experiment with nitrous oxid and oxygen, and from 1903 until Dr. Brown's removal from Cleveland Dr. Scott used nitrous oxid almost exclusively in his surgical work. I saw much of this and was so impressed by it that I had Dr. Brown give an occasional anesthetic for me, but its use did not become popularized until another team appeared on the scene composed of Dr. C. K. Teter as anesthetist and Dr. C. B. Parker as surgeon. Dr. Teter's apparatus was so superior to anything before used, and his personal skill and anesthetic knack so great, that nitrous oxid and oxygen were soon in great demand and Dr. Parker was able to present a paper reporting 218 personal cases anesthetized in this manner from July, 1904, to March 5th, 1907. Dr. Teter's first anesthetic for an abdominal operation was given to a patient of Dr. Parker's in July, 1904.

The first time in his experience that nitrous oxid and oxygen were preceded by a hypodermic of morphin was in a patient of my own in July, 1905, and in December, 1906, Dr. Teter and myself used a combination of local and light nitrous oxid and oxygen general anesthesia for an abdominal operation in a desperately ill patient who during convalescence from typhoid developed suppuration in an ovarian cyst. Also in December, 1906, nitrous oxid and oxygen was first given to a patient of Dr. G. W. Crile's, the anesthetist being Dr. Sloan, and in January, 1907, Dr. Teter gave nitrous oxid and oxygen to a patient of Dr. Crile's.

Thus the period from 1902-3 up to and including 1907 was marked by the opening of the present era of extensive use of nitrous oxid and oxygen as a general surgical anesthetic. During and since that time Dr. Teter has given 14,113 anesthetics for general surgical procedures, while it is also in constant use at Lakeside Hospital. Indeed, in a communication to the *Ohio State Medical Journal* for October, 1915, Dr. Wm. D. Fullerton states that the Lakeside Clinic has borne the brunt of the development of this method of anesthesia for major surgery.

I believe that it is true that the practically universal use of nitrous oxid and oxygen in the Lakeside Clinic has called more widespread attention to its value than the work of any other clinic or hospital, but this published statement does an injustice to the real pioneer in this work, who was Dr. Ernest E. Brown. If one also takes into consideration the fact that Dr. Teter had administered nitrous oxid and oxygen to 4,980 surgical patients previous to 1909-10, when he installed the nitrous oxid plant in Lakeside Hospital, and that the present method differs hardly at all from those Dr. Teter was then using, the erroneous nature of this statement is obvious. The error in all likelihood is wholly unintentional and but serves to illustrate how one's vision may be limited by his enthusiastic appreciation of his own colleagues and institutions. In like manner I may be overlooking some other man's work carried on either previous to, or coincidently with, that in Cleveland and shall be very glad for any correction in this sketch of the recent history of nitrous oxid and oxygen anesthesia. After all, the matter of priority is of little moment and might with propriety be dropped from the discussion of any scientific subject, but if it must be mentioned at all it should at least have the merit of accuracy.

Nitrous oxid and oxygen anesthesia does away with some of the disadvantages of ether. It is pleasant to inhale and leaves no terror in its wake. It annuls pain as certainly as does ether, post-anesthetic vomiting is nil if the gas is pure, although post-operative vomiting is still present in abdominal operations. On the authority of both Dr. Bevan and Dr. Crile, it does not lower the natural powers of the body to resist infection as does ether, but on this point I think we may suspend judgment. One thing seems certain, there is no such thing as nitrous oxid poisoning per se while there certainly is such a condition as ether poisoning. A nitrous oxid fatality I believe always to be a fatal asphyxia due to deprivation of oxygen and not a true poisoning at all.

Nitrous oxid does not irritate the mucosa of the respiratory organs, it causes no increase in the salivary secretions, it does not irritate the kidneys. Pneumonia, therefore, is not precipitated by its use, although pneumonia does occur after operations performed under nitrous oxid. It does not light up latent tubercular foci to renewed activity, and never causes nephritis and suppression of the urine.

Inasmuch as nitrous oxid can be given over a prolonged period without poisoning, it is the anesthetic of choice for operations which for any reason are likely to be very prolonged, such as extensive resection of the glands of the neck, and for multiple operations like plastic operations on the female genitalia followed by intra-abdominal operations at the same sitting. But even this innocuous anesthetic has its drawbacks. If painful stimuli are conveyed to the unconscious brain to cause shock, then as light an anesthesia as is produced by nitrous oxid should markedly predispose to shock. That it does not do so seems to me to be irrefutable evidence of the fallacy of this view. In fact, the storm around the question of whether the brain cells suffer from unfelt pain seems about as reason-

able as the discussion of whether sound exists where there are sound waves but no auditory apparatus to record them. It does not matter whether we insist that sound waves are sound or their recognition. To us there is no sound unless we recognize it.

About other drawbacks there can scarcely be an argument. If pain causes shock, and recognized pain certainly does, then post-operative shock will come on after nitrous oxid anesthesia, because the awakening is so prompt after withdrawal of the anesthetic. To obviate this, as well as to follow the dictates of humanity, either a lasting local anesthetic must be used in the painful areas or else opiates must be given early and often after operations which in themselves are productive of severe after pain. The contrast between the appearance of a patient as he leaves the surgery after an appendectomy under nitrous oxid, for instance, and that patient an hour later is something startling unless morphin has been administered in liberal amounts.

Quinine and urea hydrochlorid is the only local anesthetic of which we have any knowledge that is sufficiently lasting to retain its effects for more than half an hour, and quinine and urea hydrochlorid positively and certainly interferes with wound healing in a fair percentage of the cases in which it is used. Neither cocain nor any of its derivatives or congenors lasts long enough to be of any use, and all of us know the reaction pain when the effect of these drugs wears away.

Personally, then, I prefer the opiate, one dose immediately preceding the anesthetic and another as soon as consciousness returns.

Muscular rigidity, however, is the chief drawback to nitrous oxid. This does not interfere in the least with a thyroidectomy, a cervical adenectomy, a perineal prostatectomy, a breast amputation, or the amputation of an extremity, but all of these combined do not equal the number of intra-abdominal operations which are performed in the course of a general surgical practice. In some abdominal operations nitrous oxid anesthesia offers an insuperable obstacle to the proper completion of manipulations. I believe I am quite within the truth in stating that cholecystectomy would be impossible of performance in an obese woman who had never borne any children, if nitrous oxid-oxygen were our only anesthetic agent. Nitrous oxid muscular rigidity is also responsible for protruding gut in every laparotomy upon patients not desperately ill, or in whom the abdominal wall is not greatly distended by a large tumor. It thus leads to more handling of gut and packing away with sponges than would be necessary otherwise, and to more bruising of wound edges than would be in the case with ether.

Not the least of the drawbacks of nitrous oxid and oxygen anesthesia is the utter impossibility of doing a satisfactory exploration of the entire abdomen unless a huge incision is made. At the present time surgery is undertaken fearlessly in a large number of instances in which the topical diagnosis is uncertain, or in which, a diagnosis having been made, it is proven erroneous when the suspected organ is exposed. I need only cite the confusion in the differential diagnosis as between gastric, gall bladder, and appendicular disease and the frequent association of all three. If the diagnosis of gastric ulcer, for example, is confirmed by a high median incision, the operator is only too likely to stop short and make no attempt to see or feel the appendix if the patient is under nitrous oxid.

The duration of an abdominal operation is longer under nitrous oxid than under ether, other things being equal, and there are instances, like some operations for ruptured ectopic pregnancy, in which a few minutes makes the difference between a recovery and a death.

It is said that nitrous oxid is easier on the patient but harder on the operator, but I wish to call attention to the fact that anything which causes undue fatigue on the part of the operator is also dangerous for the patient.

Nitrous oxid positively demands an expert anesthetist. The margin of safety seems to me to be narrower with gas than with chloroform, although resuscitation is easier. Be this as it may, if I had to undergo anesthesia myself at the hands of a tyro and only chloroform and nitrous oxid were available, I should choose chloroform.

I have been speaking of pure nitrous oxid and oxygen anesthesia, but the addition of a small percentage of ether changes the picture quite materially, and it is nitrous oxid-oxygen-ether which must be used if one is to work satisfactorily in the abdomen. Even with this combination the same drawbacks exist but in a minor degree. All the difficulties are not overcome unless ether is given freely enough to make the anesthetic to all intents and purposes an ether anesthetic. In other words, one must work against obstacles in abdominal operations if nitrous oxid predominates in the anesthetic mixture. It becomes, therefore, a matter of judgment to select the proper anesthetic for the patient, and strike a balance between the known advantages and disadvantages of both anesthetic agents.

I have avoided the question of local anesthesia because that is a question which does not interest the professional anesthetist, and I have also avoided

any reference to spinal anesthesia for the same reason. Certain methods of anesthesia have been passed because they are peculiarly within the province of the anesthetist and their use contingent upon his training. I refer to rectal, intratracheal, and intrapharyngeal anesthesia under pressure. I should like, however, to devote a moment to combined local and general anesthesia in desperately ill patients. Used as a sequence, not simultaneously, it has enabled more than one patient on the verge of death to recover, and many others to be given a chance to fight for life, through the successful performance of an operation which could not have been conducted under general anesthesia alone. The operation proceeds as far as is comfortable for the patient under local anesthesia alone, and either nitrous oxid or ether is begun so soon as complaint is made of some discomfort, with the result that the patient takes but little of the general anesthetic. First, because he does not resist, and second, because the pain is far from unbearable. Ordinarily the major part of the operation is finished by the time the patient is fully asleep, and the wound is sutured before he is entirely awake. The merit in this procedure seems to me to be in minimizing the amount of general anesthetic required, and not in any shock inhibiting quality resident in the local anesthetic used.

To summarize: Any of the three most generally used inhalation anesthetics fulfills the first and prime essential of abolishing operative pain, but chloroform is dangerous enough to banish it from general consideration unless under exceptional circumstances.

Ether is many times the anesthetic of choice because of the simplicity of its administration, the wide margin of safety between ether anesthesia and ether death, and the perfect relaxation of the abdominal muscles, and in spite of the disagreeable odor and nasty after effects it must often be chosen.

Nitrous oxid is perfectly satisfactory so far as remote danger is concerned, but is far from safe at the time of its administration unless given by an expert. In ordinary operations upon the mouth, throat, neck, thorax, kidneys, bladder, cervix, and vagina, as well as operations upon the extremities, it is perhaps the anesthetic of choice. In multiple gynecological operations it presents great advantages, as it does in other operations bound from their nature to be protracted.

In most, but not all, abdominal operations it presents great disadvantages, some of which are lessened by the simultaneous use of a small percentage of ether, but none of which are entirely abolished unless ether is given with sufficient freedom to present most of the ether disadvantages.

After all, there is at present no one perfectly satisfactory, universally applicable, anesthetic or combination of anesthetics which fulfill all the essentials, and the only solution of the problem is for the surgeon and his anesthetist to be capable of good team work and adapt both the anesthetic agent and the method of its administration to the case in hand.

It remains the bounden duty of organizations such as this one to work out the problem, and it is for this reason that men with professional training must be encouraged to take up the study of anesthesia. An occasional nurse may acquire the knack of anesthesia and may by experience become a capable anesthetist, but she is fitted neither by education nor training to work out anesthetic problems. It is therefore the bounden duty of surgeons to encourage the professionally trained anesthetist to continue in that line by dignifying the position which the anesthetist holds, working with him on the problems involved, and seeing that his remuneration is sufficient to enable him to live on the fees which he obtains in his chosen line. In this way and this way only can the question of anesthetic essentials be settled and settled right.

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MAGNESIUM SULPHATE ANESTHESIA.*

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Our experiments with magnesium sulphate anesthesia have been limited to the lower animals. Three cats and thirteen dogs were used. Some of them were used for more than one experiment. Nineteen experiments were performed. Magnesium sulphate was used in steril solutions of M [1] and 25 per cent. strengths. They were injected subcutaneously, subcutaneously and intramuscularly, intramuscularly, intraspinally and intravenously.

The work of Meltzer, Auer and others was almost ignored, in order that impartial observations might be made. In experimental work it is necessary to find the toxic as well as the therapeutic dose. Such experiments are made only upon the lower animals.

Subcutaneous injections were used in four experiments. These solutions were 25 per cent $MgSO_4$.

Respirations were increased in all cases.

* Read during the Organization Meeting of the Interstate Association of Anesthetists in Cincinnati, May 4, 5, 1915. From the B. Merrill Ricketts Experimental Surgical Research Laboratory.

Dog, 9, weighed 45 pounds. The injections were made in the inner side of the right hind leg and corresponding inguinal region. This dog became sleepy; but was not anesthetized. Not much of the fluid was absorbed during the experiment.

Respiratory paralysis and death was produced in cat 4, and dog 7. A mortality of 50 per cent. They received 6cc. and 7cc. per pound of a 25 per cent. solution of $MgSO_4$.

Intramuscular and subcutaneous injections were combined in one dog. Anesthesia was ideal. The dog was conscious but made no outcry of pain while opening his abdomen or palpitating the abdominal viscera. He flinched when the urinary bladder was palpiated; but did not seem to be in pain.

Respirations fell as low as 6.8. He was given

TABLE 1.

Expr. No.	Weight	MgSO4 Sol.	Dosage per lb.	Respiration.	Antidote.	Result.	Anesthesia—Remarks.
Subcutaneous Injections.							
Cat 4	5 lbs.	25%	6. cc.	Rapid paralysis	$CaCl_2$ 20.cc. M/8	Table death	Complete
Dog 5	20 lbs.	25%	3. 7cc.	70 16		Recovered	Partial.
Dog 9	45 lbs.	25%	3. 5cc.	18 before 27 after		Recovered	Incomplete Sleepy.
Dog 7	17 lbs.	25%	6. 7cc.	46 8 Paralysis		Table death	Complete.
Intramuscular Injection.							
Cat 1	4 lbs.	25%	3. 2cc.	Respiratory	10cc. 5%	Table death	Complete. Abdominal Sect.
Cat 2	5 lbs.	25%	2. 4cc.	46 180 160 66 22 16 Respiratory paralysis	16cc. 5%	Death from $CaCl_2$	Complete. No Section.
Dog 6	37 lbs.	25%	3. 5cc.	18 40 30 21		Recovered	Complete. Good, Conscious, Abdominal Sect.
Dog 8	14 lbs.	25%	3. 5cc.	Respiratory paralysis	30cc. M/8	Table death	Complete. No Section.
Dog 10	15 lbs.	25%	2. 1cc.	20 36		Recovered	Complete, ideal. Section. Able to walk from table.
Dog 11	28 lbs.	25%	3. 0cc.	57		Recovered	Partial.
Intravenous Injections.							
Dog 12 (9)	45 lbs.		0.95cc.	24 30		Recovered	Complete. Conscious. Walked from table.
Dog 14 (10)	15 lbs.		0.91cc.	Respiratory paralysis		Table death	
Dog 15 (11)	28 lbs.		1.21cc.	40 42 20		Recovered	Complete. Conscious. Walked from table.
Dog 16	21 lbs.		1.31cc.	42		Recovered	Complete. Conscious. Walked from table.
Dog. 17	16 lbs.		1.01cc.	Respiratory paralysis Pulling abdominal muscles revived breathing. (Dr. Whilms.)	$CaCl_2$ 2.cc.	Recovered	Partial. Walked from table.
Dog 18	25 lbs.		0.72cc.	18 30		Recovered	Conscious to cutting, not manipulations. Walked from table.
Intraspinal Injections.							
Dog 13	35 lbs.	M/1	3.28cc. per lb.	Respirations up to 90		Recovered	Complete. Conscious. Able to walk.
Dog 19	35 lbs.	M	1.14cc. per lb.	16 30 24 28 36 34 32		Recovered	Complete. Conscious. Not able walk.

The dogs which recovered received 3.7cc. and 3.5cc. of a 25 per cent. $MgSO_4$ solution.

Magnesium Sulphate was not found to be a local analgesic.

Anesthesia was produced in 75 per cent of the cases.

Gangrene developed in the two cases which recovered. In other words in 100 per cent. of the cases.

60 cc. of a 5 per cent. solution of calcium chlorid subcutaneous and intramuscularly. This revived him. Death occurred several hours after, presumably from calcium chlorid. Post mortem: leg edematous where calcium chlorid was injected.

Intramuscular and subcutaneous.

Dog 11, 21.5 pounds. $MgSO_4$ 25 per cent. 3.6 per pound. Respirations 6.8.

Calcium chlorid 60 cc. 5 per cent. Death. Anesthesia complete.

Intramuscular injections were used in six animals. Two died on the table. One of the deaths occurred in a cat and the other in a dog. The cat received 3.25 cc., while the dog received 3.501 cc. of a 25 per cent. $MgSO_4$ solution, per pound. This gives a table mortality of 33.3 per cent. Cat 2, received 1.4 cc. of a 25 per cent. $MgSO_4$ per pound. It had respiratory paralysis which was overcome by a 16 cc. of a 5 per cent. calcium chlorid solution. This cat died some hours after. Its death was attributed to calcium chlorid. Edema was present in the leg where calcium chlorid was injected.

TABLE 2.

Animals Recovering Without Respiratory Paralysis.

Experiment No.	$MgSO_4$ Sol.	Amount.	Time of Administration, Hours, Minutes.
		Subcutaneous Injection.	
Dog 5	25%	3.7cc.	One hour, 17¾ minutes.
Dog 9	25%	3.5cc.	17 minutes.
		Intramuscular Injections.	
Dog 6	25%	3.5cc.	11 minutes.
Dog 10	25%	2.1cc.	22 minutes.
Dog 11	M/1	3.9cc.	One hour, 14 minutes.
		Intraspinal Injections.	
Dog 13	M/1	3.22cc. Lumbar	32 minutes.
Dog 19	M/1	1.1cc. dorsal	38 minutes.

TABLE 3.

Animals that Died or had Respiratory Paralysis.

Expr. No.	$MgSO_4$ Sol.	Amount.	Time of Administration.	Fatality.
		Subcutaneous Injections.		
Cat 4	25%	6. cc.	:12 mins.	Res. paralysis in 2 minutes.
Dog 7	25%	6.7cc.	1:26 mins.	Died 29 mins. after last dose.
		Intramuscular Injection.		
Cat 1	25%	3.2cc.	In one dose	Res. failure in 11 mins. Death.
Cat 11	25%	1.4cc.	In one dose	Res. failure in 32 mins.
Dog 8	25%	3.5cc.	3½ mins.	Died in 7½ mins.

Respiratory paralysis did not occur in 50 per cent. of the cases in this series. The animals which recovered, received 3.5 cc., 2.13 cc. and 3.014 cc. of a 25 per cent. $MgSO_4$ solution. Dog 10 received 2.13 cc. and dog 11, 3.01 cc. Anesthesia was ideal in the former and partial in the latter. These two experiments show how unreliable the dose is when used in the muscles.

Dog 10 had her abdominal wall opened to the peritoneum, no pain. She was conscious and able to walk when removed from the table.

Gangrene occurred in 66.6 per cent. of the cases which recovered.

Intraspinal injections were given upon two different occasions. An $\frac{M}{1}$ solution was used in each of the experiments. In one experiment 3.28 cc. per pound were used in the lumbar region, while in the other 1.14 cc. per pound were used in the dorsal region. In each experiment a large quantity of fluid escaped around the needle. More escaped, however, in the first than in the second experiment, which probably accounts for the difference in the dose.

Anesthesia was ideal in each experiment.

TABLE 4.

Animals that Recovered Without Respiratory Paralysis.

Expr. No.	$MgSO_4$ Sol.	Amount.	Time of Administration.	Outcome.
		Intravenous Injections.		
Dog 12	M/1	.95cc.	53 mins.	Recovered
Dog 15	M/1	1.21cc.	25 mins.	Recovered
Dog 16	M/1	1.31cc.	16 mins.	Recovered
Dog 18	M/1	.72cc.	33 mins.	Recovered

TABLE 5.

Animals that Died or had Respiratory Paralysis.

Expr. No.	$MgSO_4$ Sol.	Amount.	Time of Administration.	Fatality.
		Intravenous Injection.		
Dog 14	M/1	.91cc. to lb.	1 min.	Res. paralysis in 1½ mins. after last dose.
Dog 18	M/1	1.01cc. to lb.	All but 2cc. in 9 mins. 2cc. at 19 minutes.	Res. paralysis in 10 mins. after last dose. Recovery.

Gangrene developed at the points where the fluid escaped in each experiment.

Intravenous introduction of $MgSO_4$ $\frac{M}{1}$ solutions, were used in six dogs. These solutions were injected into the jugular vein. Our ansepsis was not perfect in all of these cases and as a result there was some wound infection. In some cases the solution escaped from the vein into the tissues. There were no large sloughs as gangrene in this series. The mortality was 16.1 per cent.

Dog 14, which died, received the reasonable dose of .915 cc. per pound. The method of administration was faulty, since all of the solution was given within 1½ minutes. While the last dose was being given retching occurred. Respiratory paralysis resulted in 1½ minutes after the last dose was injected.

From our results it seems that $MgSO_4$ in $\frac{M}{1}$ solutions may probably be safely given, if none of the $MgSO_4$ escapes in the wound. If it does escape it should be washed out of the wound and the wound drained. The jugular veins were found to be obliterated when the dogs were killed.

Muscular relaxation occurs first in the abdominal

muscle. In some cases the abdominal muscles were completely relaxed, while the animals were able to raise their heads.

It was noted in some instances that the abdominal muscles were but partially relaxed when anesthesia occurred. In an intravenous case the abdominal muscles were relaxed before the required dose was finished. Relaxation occurred in some animals within one to fourteen minutes after the last dose. It was impossible to make these observations in all the experiments.

In action $MgSO_4$ is very similar to ether or chloroform. There is an increase in respiration, excitement in a small per cent. of the cases, nausea, vomiting, reduction of respiration, anesthesia with consciousness in some cases, sleep with anesthesia and finally respiratory paralysis if the dose is large enough. Nausea and vomiting are toxic symptoms.

The accompanying tables contain the doses, time consumed in injecting the drug as well as other details and the results.

Observations from Our Experiments.

(1) Magnesium is toxic in large doses.

(2) That it will cause respiratory paralysis.

(3) That it will cause general anesthesia, although the animal is conscious.

(4) That it will cause sloughing, and gangrene in some cases, when introduced subcutaneously or intramuscularly. Or when it escapes into the muscles or connective tissue.

(5) That it is not a local anesthetic.

(6) That the toxic and therapeutic dose vary in different dogs.

(7) That the time required to inject is about 30 minutes.

(8) That when the dose is given in too short a time, respiratory paralysis or death may result.

(9) That the intravenous route is the best.

In closing, it must be remembered that our mortality is connected with experiments, and that in some cases the life of the dog was not considered.

Finally: I wish to thank Dr. J. H. Wilms for his kind assistance and suggestions while this work was in progress.

8 WEST 9TH STREET.

DISCUSSION.

DR. J. H. WHILMS, Cincinnati, O: The analgesia of the magnesium salts has been known for a long time and its specific effects on the neuron would occupy much time and theorizing to adequately discuss them. These experiments have brought to our attention very forcibly the disastrous effects of the subcutaneous use of magnesium sulphate in the production of gangrene. That it will produce anesthesia when injected subcutaneously, intramuscularly and intravenously, in varying amounts; that it has a definite toxic effect more or less uniformly simulating shock with nausea, vomiting and paralysis of respiration we think we have demonstrated. These effects can be controlled by a measured dose and also by a gradual administration only when given intravenously. Dr. DeNeen certainly deserves a great deal of credit for his persistence in these experiments as I was often discouraged at the results we obtained. However, magnesium sulphate may some day be used as an analgesic for operative work, as it produces a complete anesthesia and relaxation with consciousness—providing we are able to eliminate in some way its toxic effects.

EDEMA OF THE LARYNX DURING ANESTHESIA: A REPORT OF TWO CASES REQUIRING TRACHEOTOMY, WITH RECOVERY OF BOTH.*

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Two Cases Requiring Tracheotomy with Recovery of Both.

CASE 1.—Mr. H. B., Male, white, age 40, weight 190 lbs., height about 5 ft., 7 in., with a short thick neck and a great deal of swelling on the left side of the face and neck.

Present illness.—Infection around the teeth with general cellulitis of the left side of the face and neck.

Anesthetic.—This case occurred about eight years ago when I was an interne in the George Washington University Hospital. At that time chloroform was used in about 50 per cent. of the cases operated upon, so I was instructed to give him chloroform. The patient was not excited or nervous and did not object to taking the anesthetic. There was no apparent obstruction of breathing. Chloroform was started slowly by the drop method. There was no talking, holding of breath, coughing, struggling, or any difficulty in taking the anesthetic. In fact it did not seem possible for a person to take chloroform with any less trouble or difficulty than he was having.

I had been giving the chloroform about three or four minutes and the patient was starting in the second stage of chloroform anesthesia, without any excitement, when suddenly there occurred complete obstruction of the respiration. There were violent respiratory movements, but as there was no air entering the lungs he was deeply cyanosised in a few seconds. The anesthetic was stopped, the head lowered, the lower jaw was raised, traction was made on the tongue with a pair of forceps, and pressure was made on the chest, all without relieving the condition. When his trouble first started, I thought it was the usual excitement stage that we often have in the robust, and was only muscular spasms that would soon clear up with stopping the

* Read before the District Medical Society, Washington, D. C., May 19, 1915.

anesthetic. But finding that I could not get any air in the lungs by the usual methods, and that he was rapidly getting worse, Dr. W. P. Carr was called from the wash-up room. The patient was put on the operating table and Dr. Carr quickly did a tracheotomy. There was some difficulty in opening the trachea, so that by this time it was impossible to get the radial pulse, and respiratory effort had almost ceased, although we could get the heart beat over the apex region with ease. As soon as the trachea was opened there was a marked inhalation of air, and the respiration and pulse soon approached normal.

From the time the edema occurred until the trachea was opened was only about three minutes, and I feel quite sure that another minute or two in this case would have caused us to have had a fatal result. By the time the tracheotomy tube was fixed in place, the patient had reacted sufficiently, that in order to do the operation more anesthesia was needed. This was given by dropping the anesthetic on gauze placed over the tracheotomy tube. This also shows that the edema was not caused from an overdose of the chloroform, but rather by the irritation of the same.

On taking a post-operative history in this case he stated that about two years previous they had attempted to operate upon him for some infection about the teeth, under chloroform anesthesia, with the result that at that time they had to perform a tracheotomy to prevent a fatal result. The scar tissue from the first tracheotomy explains why Dr. Carr had difficulty in opening the trachea at this time.

CASE 2.—Mr. M. N., Male, white, age 42, well developed, weight 185 lbs. Gave a history of three previous attacks of peritonsillar abscess. He came to the dispensary of the George Washington University Hospital with the 4th attack, where Dr. E. Y. Seibert made an attempt to open the abscess, but had to give it up because of the marked rigidity of the jaws. The jaws were so firmly fixed that it was impossible to get a tongue depressor between them in such a manner as to depress the tongue enough to expose the abscess.

Dr. Seibert decided he would need a general anesthetic to relax the jaws sufficiently to open the abscess. So he sent him to the ward, and requested his assistant, Dr. Tibbits, to open the abscess under a general anesthetic. Before the anesthesia was started there seemed to be very little interference with breathing.

I began with ether by the open method and had no trouble until he entered the second or excitement stage of anesthesia. Then there was struggling, coughing, holding of the breath, and some cyanosis, but on stopping the ether for a few minutes he would clear up. A number of attempts were made to get him under the anesthetic long enough to relax the jaws, but each time he would become cyanosed. On stopping the ether the last time the cyanosis failed to clear up. Respiratory effort was about normal, pulse 96, and as the jaws were still rigid it was impossible to open the mouth to make traction on the tongue or raise the lower jaw.

Obstruction was not complete as in the other case, but he was not getting enough oxygen and his cyanosis was getting worse. His head was lowered and turned in various positions trying to remove the obstruction, pressure was made on the chest, and I tried to force oxygen in the lungs with the pulmotor, but could not see that it was of any aid. After several minutes the jaws relaxed apparently from the deep cyanosis. Then the tongue was pulled well out, the lower jaw was raised, and with a spongue on a holder his mouth and throat were freed of mucous, but this still did not relieve the obstruction. His pulse was now 115 per minute, so I suggested to Dr. Tibbits that he cut down on the trachea and be ready to do a tracheotomy in case we could not remove the obstruction. We again tried the pulmotor, but with no good results. The pulse was now about 140 per minute and the respiratory effect was getting weaker, so that I did not feel justified in trying anything else. So Dr. Tibbitts now finished his tracheotomy and the patient's color, respiration and pulse gradually returned to normal. The abscess was now opened and the patient sent back to the ward. By this time he had completely reacted. In this case from the time the ether was stopped until the trachea was opened was about 10 to 12 minutes.

When the above condition occurs during anesthesia there are a number of conditions that it might seem to be that you have to consider. First the *muscular spasm* which frequently occurs during the second stage of anesthesia, but usually clears up by stopping the anesthetic for a short time. Other conditions are spasm of the glottis, bulging of the abscess sack or relax tissue into the larynx or trachea, rupturing of a peritonsillar abscess, or an undiscovered deep seated abscess, or the aspiration of food, pus, or mucus into the trachea.

I wish to quote a few extracts to bear out my previous statements.

Gwathemey states: "Muscular spasms are prone to characterize the ordinary administration of

chloroform, this tendency being greater the more vigorous is the muscular development of the subject. The muscles of the extremities, abdomen, chest, *larynx, neck* and *jaws* are particularly apt to be involved in tonic spasms during the earlier stages of the anesthesia." With regard to nitrous oxid anesthesia, he states further: "The author knows of one case in which a fatality occurred when nitrous oxid oxygen anesthesia was given for the extraction of a tooth, and an undetected abscess at the base of the tongue burst at the height of anesthesia and immediately filled the patient's lungs with pus, the patient dying within three minutes." (*Anesthesia—Gwathmey,* p. 303 and 330.)

In discussing surgery of the larynx, Keen says: "In many cases of edema from severe tramma, erysipelas, of Ludwig's angina, the development of the symptoms is so rapid that death may ensue before a surgeon can be summoned. Lennox Brown reported an instance where a man suddenly developed an edema while sitting in the waiting room of a public dispensary where he had gone for treatment of another disease. In this case death occurred in a few minutes before the attending staff could perform tracheotomy." He states under prognosis: "The prognosis in conditions complicated by the edema of the larynx is always grave." Under treatment he states: "In all cases, however, in which the life of the individual is threatened, no time should be wasted by a trial of milder methods as tracheotomy is positively indicated as the only rational treatment." (Keen's Surgery, Vol. iii., p. 480.)

Bishop in referring to the same subject, writes: "Occasional deaths have occurred from tonsillar abscess emptying into the larynx or causing laryngeal edema." (*Diseases of the Nose, Throat and Ear—Bishop,* p. 201.)

The two cases reported above bring to mind some things of importance that are often neglected. (1) We should have a complete history in all cases. With a history in the first case, we more than likely would have used ether instead of chloroform, although the result probably would have been the same. (2) I think we often underestimate the danger of infections of the mouth and throat. (3) The importance of operating in such cases in a hospital, where we are prepared for all emergencies, rather than at home, where they would cause a panic and possibly prevent a good result. (4) The rapidity with which fatal laryngeal edema can occur without any warning previously.

606 SIXTH STREET.

ON THE RATE OF EVAPORATION OF ETHER FROM OILS AND ITS APPLICATION IN ETHER-OIL COLONIC ANESTHESIA.*

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It is conceded that the anesthetic agent must get into the blood for distribution and for eventual elimination, whatever theory of general or central anesthesia one may support. The anesthetic agent has normally been introduced into the blood by inhalation or intravenously. It is normally eliminated via the lungs.

The intestinal mucous membrane of vertebrates is well known as an efficient transmitter of gases to and from the blood. Pirogoff[1] appears to have been the first to mention the administration of ether by this route. Liquid ether was used until Magendie gave warning as to the danger of its use and ether vapor was substituted. During the same year Roux,[2] y'Yhedo[3] and Duprey[4] employed liquid ether or aqueous mixtures to induce complete anesthesia. Although Pirogoff's enthusiasm prompted him to predict the supplanting of the inhalation procedure by the rectal method, references to it disappeared from the literature until 1884. Then Molliere[5] revived interest in the method by using a hand bellows for forcing the ether vapor into the intestine. Variations in the technic were introduced during the same year, but the experiences of Yversen, Harter, Bull,[6] Weir,[7] Wancher[8] and Post[9] showed more or less diarrhoea and melena as after-effects. These after-effects, with one case of death directly attributable to the procedure, caused the method to again fail in securing serious recognition until 1903, when Cunningham[10] employed air as a vehicle for sweeping the ether vapor into the colon. In 1909 Lueguen, Money and Verliac[11] used oxygen as the vehicle for the ether vapor. Buxton[12] in his splendid book on *"Anesthesia"* says that he found the procedure most satisfactory for certain operations, for example, those having to do with the mouth, nose, etc., but he remarks *"Deaths have occurred."* Sutton's[13] introduction of a return flow tube for these gases introduced and unabsorbed constituted a distinct advance in anesthesia by colonic absorption.

In an effort to avoid certain well known difficulties in intravenous anesthesia, Gwathmey ex-

* Read before the American Philosophical Society, Philadelphia, April 23, 1915; the New York Section of the American Chemical Society, June 11, 1915, and the American Association of Anesthetists, San Francisco, June 21, 1915.

perimented with mixtures of normal saline solution and ether per rectum. The concentration of ether in the aqueous solution was so small that excessive volumes of liquid were needed, and furthermore the ether parted from the solution so very rapidly that experimentation along those lines was abandoned. Gwathmey then applied a solution of ether in olive oil. As oil and ether make perfect solutions in all mixtures, it was his hope to

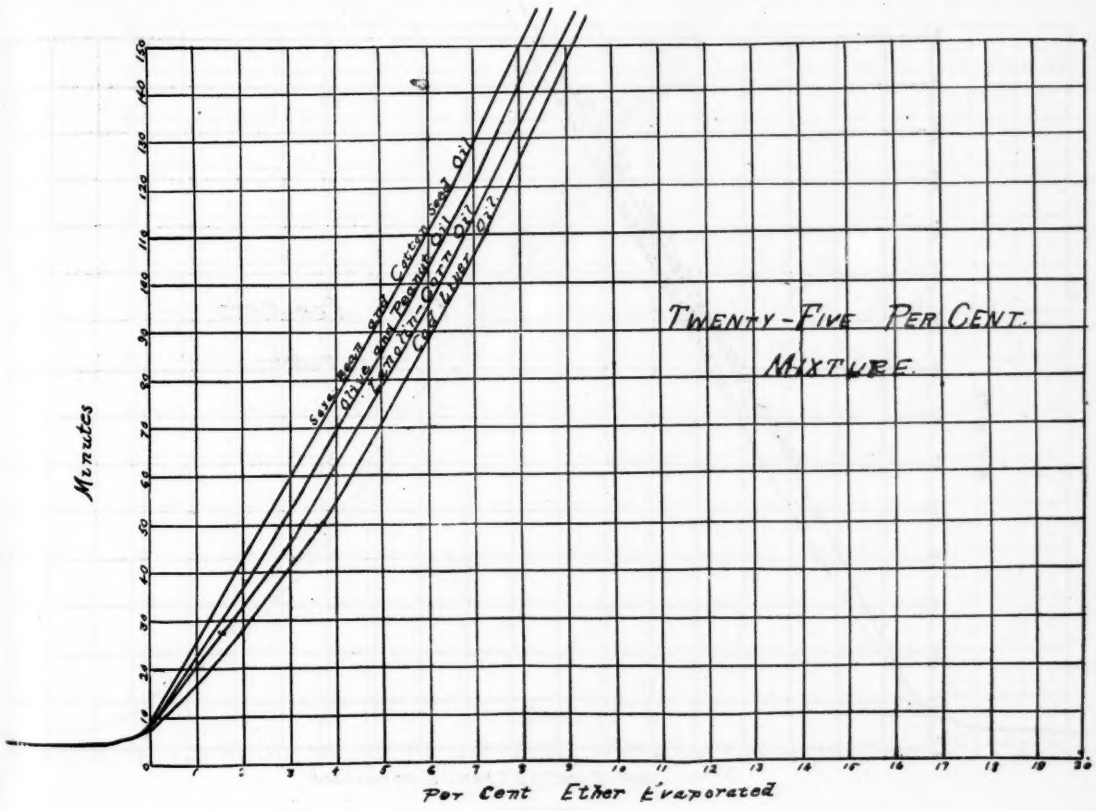

CHART I.

reduce the total bulk of the fluid introduced into the colon by using a stronger solution of ether in oil than is possible with any known aqueous mixture. As oils are lubricants it was also hoped to avoid the irritation of the mucous membrane previously noted. The ether may always be separated from the oil by warming, but unless the temperature of the mixtures is suddenly raised to an excessively high point, the ether passes off deliberately. It was thought that the evaporation of the ether would induce some cooling of the mixture with a consequent checking of the evaporation and its absorption. These premises coupled with slow absorption by the colon in comparison with the rapid elimination by the lungs would automatically regulate any anesthesia that might be induced in this manner. As a result, Gwathmey presented a paper before the 17th International Medical Congress in London in 1913 on the work with animals done by himself and Wallace.

At the request of my co-laborer, Gwathmey, I undertook an investigation on the rate of evaporation of ether from oils to secure the following information that might be of service to him in his further application of his ideas with human subjects:

1. A comparison of the rate of evaporation of ether from different mixtures of ether and the same oil;

2. A comparison of the rate of evaporation of ether from the same per cent. mixtures of different oils and ether; and

3. The influence of surface on the rate of evaporation was determined.

As the result of much preliminary experimentation, the following mode of procedure was settled upon. Large glass tubes were calibrated to 1 cc. from 20 cc. to 105 cc. The mixtures of 25, 50 and 75 per cent. of oil and ether were carefully

placed in the tubes. The tubes were weighted with lead and placed in a thermostat, whose temperature was so regulated as not to vary more than 0.03° C. from 37° C., the same being controlled by a toluene-mercury temperature regulator. All connections (gas, water, etc.) were made with lead pipe for safe use over night, as occasion arose. The water in the bath was stirred by a system of paddles and shaft operated through belt and pulleys by a small hot air engine. The tubes were immersed in the bath to within 2 cm. of the tops. During the first five minutes two readings were made in each case to get the highest point to which the volumes expanded upon heating up to 37° C. After that readings were made every five minutes for two or three hours.

Since the evaporation of any liquid depends upon the partial pressure of that liquid at its surface, the higher the glass wall above the surface of the oil-ether mixture, the heavier the column of ether vapor resting on the surface of the mixture, the slower will be the evaporation, consequently the different oil mixtures with the different percentages of ether were experimented with in the same tube filled to the same height in each experiment.

In the experiments to determine the influence extent of surface played upon the rate of evaporation, the same precautions were taken as to height of walls of the containing vessels. In the largest areas worked with, this involved using as much as 600 cc. of the mixture. As the 75 per cent. mixture has been found most satisfactory clinically, this was determined with that mixture only.

The ether used was that prepared under my supervision and was 97 per cent. absolute with 3 per cent. absolute alcohol, being free from acids, aldehydes, and water.

The oils used were of three types, vegetable, animal and mineral, being respectively, olive, cotton seed, corn, peanut and soya-bean; cod-liver and lanolin (anhydrous), and Russian mineral oil. All the vegetable oils, except olive, were refined by a process devised by the author[14] and were neutral. The other oils were purchased in the open market.

The experimental work was carried out by Mr. Hyman Storch, under my direction.

The data obtained for the 25, 50 and 75 per cent. mixtures vegetable and animal oils are shown graphically in Charts I., II., and III. below. In

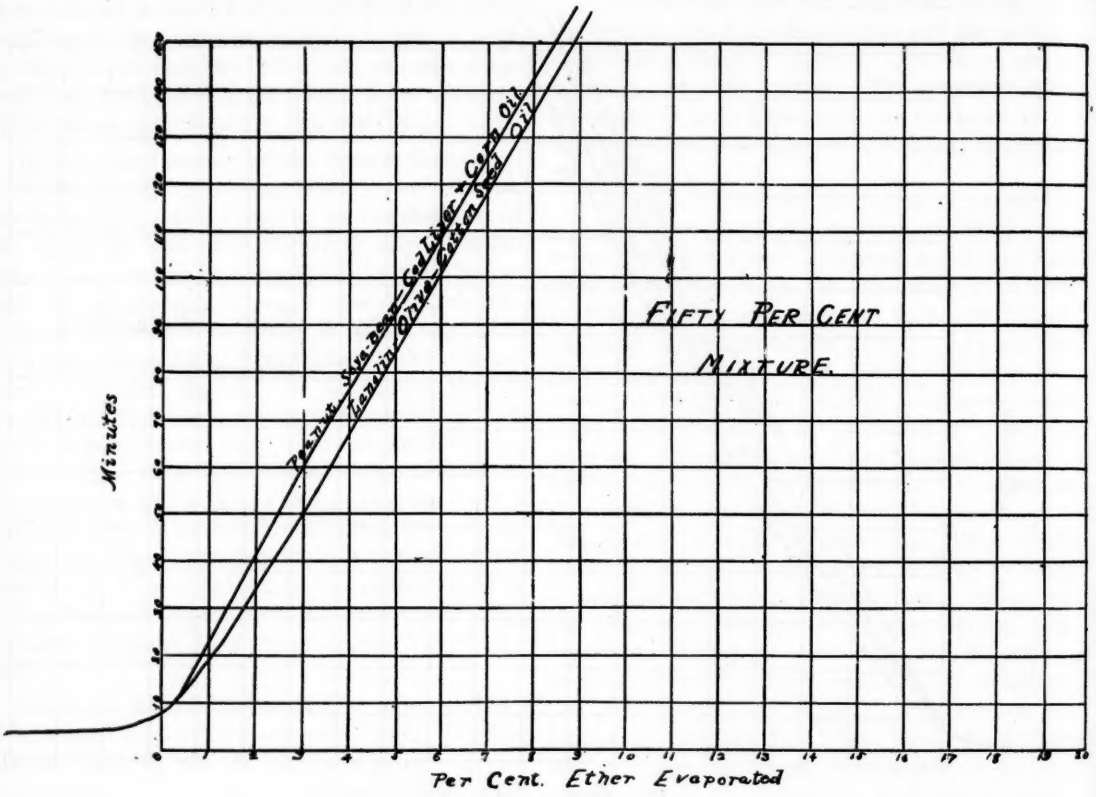

CHART II.

the curves the abscissae show the percentage of ether evaporated (based on volume measurements) and the ordinates time of the evaporation.

Chart IV. (selected at random from charts made for each oil) shows the difference in rate of evaporation 25, 50, and 75 per cent. mixtures with one oil.

Chart V. shows the effect of increased surface on the rate of evaporation. One oil only was selected to show the principle which is, the rate of evaporation bears a direct ratio to the surface exposed.

These experiments were made in glass, hence they do not disclose all the factors in the conduct of such mixtures in contact with the walls of the colon, for there the principles of osmosis and diffusion are involved. But these observations demonstrated several striking facts:

1. While ether boils at 34.6° C., it does not escape violently from an oil-ether mixture, as from an aqueous mixture when the mixture is heated higher, namely, to the body temperature of 37° C.

2. The *rate* of separation of ether from the oil quickly acquires a definite and fairly fixed speed.

The significance of this conduct cannot fail to be of great importance, for by this means the proper content of ether may be maintained in the blood to produce any desired physiological effect that has a quantitative relation thereto, for example, the third or surgical stage of anesthesia.*

The last mentioned has been demonstrated clinically by Wallace, who found respiration and blood pressure fully maintained, and Gwathmey and others with records to date of about 1,000 human cases. So far, not a case of post-ether pneumonia has been encountered. The after-effects usually associated with inhalation anesthesia, unless induced by the most improved modern technique, are virtually absent, including post-anesthetic nausea. Its use for special cases involving the head, breathing passages, etc., is superior. Although having had the privilege of attending clinics, I am not qualified to pass judgment upon its value, but from what I have learned, if necessary, "Give it to me that way."

COLLEGE OF THE CITY OF NEW YORK.

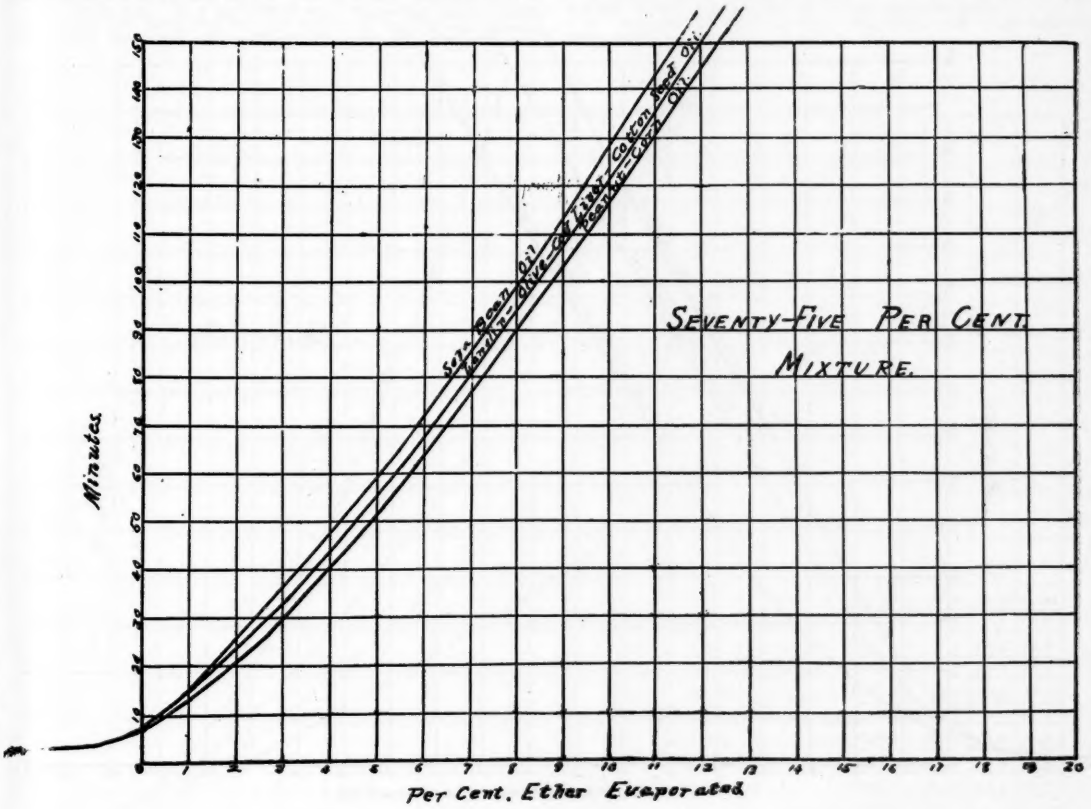

CHART III.

* In this connection it may be stated that about 30 mills of a 75 per cent. mixture to 20 lbs. of body weight is administered as an enema.

DISCUSSION.

DR. JAMES T. GWATHMEY, New York City: This is a method of anesthesia that has been very little used up to the present time, and rightly so, because in dealing with a matter of life and death we cannot be too careful or conservative. There are two factors it seems to me that have retarded its use more than anything else, and one is the fact that we put in the total amount of anesthetic at one time. This seemed to be necessary up to this time; otherwise we could not get an exact ether tension in the blood. But as you will notice by some charts that have been handed around, the ether evaporates from the oil continuously and not intermittently or irregularly. If all the ether that was placed in the rectum was evaporated at one time we would have ether anesthesia, shock and gradual recovery. But we do not have this. We have ether anesthesia, but produced and maintained in a perfectly even degree, maintained as evidenced by the results on the blood pressure, the color and other reflexes. The fact that the oil-ether mixture is in the rectum is not against this method, if you understand the accompanying charts. From these you can readily understand that the oil-ether mixture is practically outside the body. It is outside of the circulation, and it is as well out of the circulation as if it were on the outside of the body. It goes into the circulation very gradually. As the ether evaporates it cools off the mixture in the colon.

Another factor is the difference between the absorptive surface of the colon and the excretory surface of the lungs. These two things seem to maintain the anesthesia at the same level. As a professional anesthetist I am more and more convinced of the value of this method. There was a case that came to me about a week or ten days ago that will illustrate this more fully than anything else I could say on the subject. A boy seven years old, who weighed forty-three pounds, and was an only child. He was suffering from enlarged tonsils which interfered with his breathing in such a way that he could not get the proper amount of oxygen. They attempted to build him up before operating, but the child was gradually losing. His lips were blue at all times, a blowing systolic murmur being easily diagnosed, and the question of giving him any kind of anesthetic was a serious one. On consultation I told them that nitrous oxid oxygen was absolutely contraindicated in that case, for the reason that the child was already cyanosed, and to maintain anesthesia in that condition with nitrous oxid and oxygen, that the point between anesthesia and toxicity would be lessened to such an extent that it would place the child's life in danger, and the best method was rectal anesthesia, because it would do away with struggling and we could regulate and control it better. The child was brought into the city and placed in a private sanitarium. I told the nurse exactly the amount to give, and it was given, without the child seeing me or any other doctor; he did not know he was to be operated upon. He was used to getting nourishing enemas and thought nothing of that. As the child became insensible I came in and took charge of the case, and increased the depth of the anesthesia by one or two drops of ether; he was operated upon successfully and returned to bed I siphoned the amount not used by massaging the colon from right to left, with a large rectal tube in position. He came out of the anesthetic fifteen minutes after his return to bed, and he does not know now that he was operated upon; he thinks he "had a nose bleed" as he calls it. He left the sanitarium a few days later for his home.

The cases that are especially indicated for the ether-oil method are the very obese, men or women weighing from 200 to 300 pounds and over. In such cases, on account of narrowed air passages, we always have trouble in maintaining inhalation anesthesia, but with the ether-oil they behave beautifully. This is on account of the fact that they go under quietly and easily, if the patient is otherwise normal. The danger in giving this the first time might be that you would think the patient was not anesthetized, because all of the reflexes are very active, but at the same time if an incision is made the patient does not move. If you attempt to push the anesthetic and get the patient into the same stage of anesthesia you are accustomed to in inhalation methods you would have the patient in the danger zone. I used between one and a half and two ounces of a fifty per cent mixture in the boy's case, and he was about twenty minutes going to sleep. It takes a longer time when you use lower than the seventy-five per cent. It may be possible I could have done it with twenty-five per cent, but I always use fifty per cent in children. If you use a higher per cent you may not get any unpleasant symptoms, at the same time I prefer having the patient go to sleep quietly. This boy was an only child and the possibility was there would not be any more children in that family, and a great deal depended upon this surgical operation. With children, this method has not been as thoroughly worked out as with adults, and the only reason we fail, or have trouble, is because we do not get the colon entirely clean.

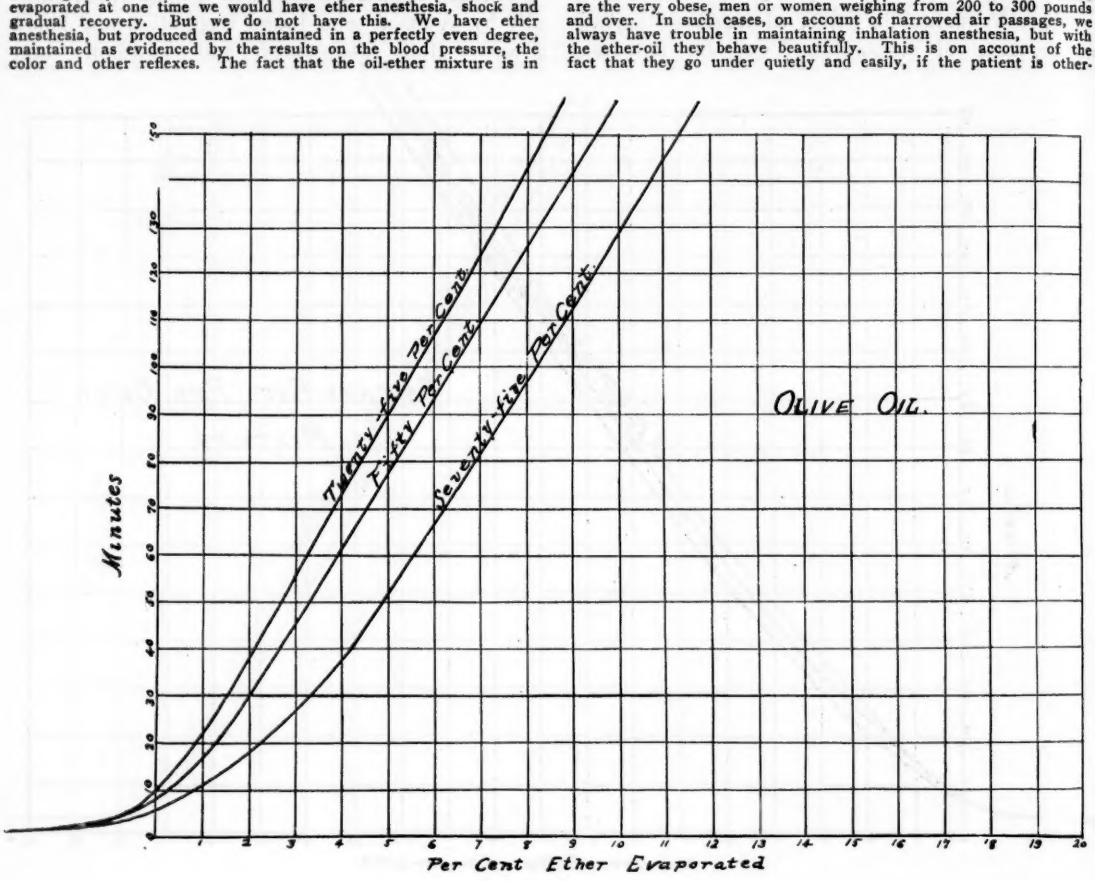

CHART IV.

DR. MARY E. BOTSFORD, San Francisco: I should like to ask Doctor Gwathmey if there is any means of increasing the depth of the anesthesia without using the inhalation method. And also if the reflexes are not completely abolished if it is possible to give it for tonsilectomies, say with a vigorous subject?

DR. F. D. BULLARD, Los Angeles: I have used quite a number of years ago ether by the vapor method by the rectum for operations on the throat, and I shall be very glad to take up this oil method, because I can see where it will be superior to anything else. I am very much pleased indeed with the paper.

DR. KATE B. VAN ORDEN, Alemeda: I would like to ask if you have complaints of any pain from the cold of the ether.

DR. JAMES T. GWATHMEY (closing): The first case I used it on was an adenoid and tonsil case. We gave the ether-oil at 11 A.M., and the child left the hospital at 3 P.M. For an adult I would give a quarter of a grain of morphine, and a ten-grain chloretone suppository an hour before the ether-oil mixture. Just lately Dr. Wallace and myself have been working to reduce the amount of ether given by any method one-half. We find we can do it by using bromide of potash, two grams. paraldehyde two grams, morphia sulph. ¼ gr., in four ounces of water, per rectum. When this preliminary is used we give only one-half the ether-oil mixture heretofore used. Where we would ordinarily use eight ounces we reduce the amount to four ounces. In other words, instead of one ounce for every 20 pounds of body weight we now give one ounce for every 40 pounds.

In regard to pain, that varies absolutely with the patient. If the preliminary medication that I have mentioned is given there is practically no pain. In a majority of cases the patient goes to sleep very quietly and easily and the only danger is that we may attempt to increase the depth of anesthesia by inhalation methods until there would be stertor, which would be very dangerous. Even in very obese patients as a rule the breathing is quiet. The only thing I have been disappointed in in this ether-oil method is that it requires as careful attention as any other method. I was in hopes it would be so simple and easy that it could be used generally without a great deal of attention, but an open air way must be maintained at all times. To increase it after the amount predetermined upon has been given, you can still give one ounce more without getting into the danger zone. You have a danger sign when you have stertor or loss of lid reflex. As long as the patient breathes quietly, with the lid reflex present, and the pulse and respiration normal, the patient is in safe anesthesia.

In regard to cold vapor, that involves a physiological question that it would take a good while to discuss and—unless you had thought of it previously—to appreciate. It is a very strange thing that in spite of the fact that the colon is cold, the temperature of the patient remains the same and the color is always good, showing that oxidization is present. With the oil-ether anesthesia the patient always inhales a somewhat warm moist ether vapor, because after the ether has been taken up by the greater circulation and carried through the liver, and excrated by the lungs, when again inhaled it is warm and moist.

The final test of the method is the clinical test, and the fact that we have given it in over 1000 cases without showing any toxic symptoms is amply sufficient.

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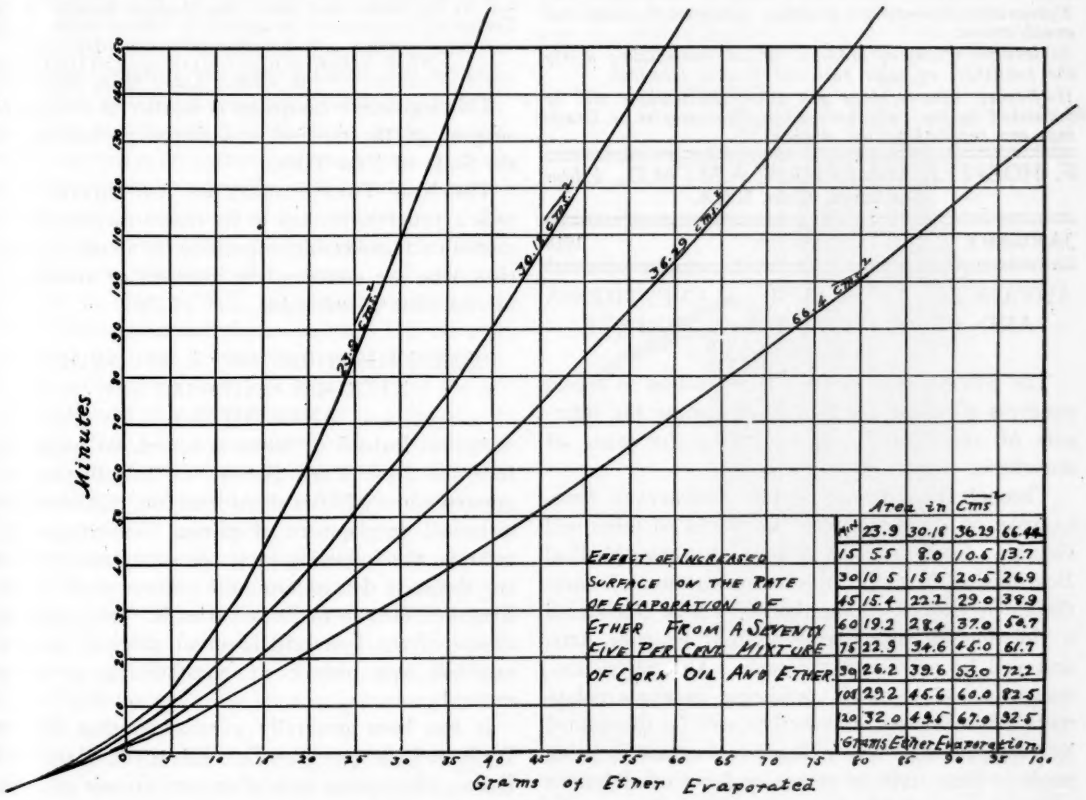
Minutes
Grams of Ether Evaporated
23.9 Cmt²
30.18 Cmt²
36.29 Cmt²
66.44 Cmt²
Effect of Increased Surface on the Rate of Evaporation of Ether From A Seventy Five Per Cent. Mixture of Corn Oil And Ether
Area in Cms²
Min | 23.9 | 30.18 | 36.29 | 66.44
15 | 5.5 | 8.0 | 10.6 | 13.7
30 | 10.5 | 15.6 | 20.5 | 26.9
45 | 15.4 | 22.2 | 29.0 | 38.9
60 | 19.2 | 28.4 | 37.0 | 50.7
75 | 22.9 | 34.6 | 46.0 | 61.7
90 | 26.2 | 39.6 | 53.0 | 72.2
105 | 29.2 | 45.6 | 60.0 | 82.5
120 | 32.0 | 49.6 | 67.0 | 92.5
Grams Ether Evaporation

CHART V.

FEATURES IN THE APRIL SUPPLEMENT.

PERSONAL EXPERIENCES WITH ANOCI-ASSOCIATION.
WALLACE IRVING TERRY, M.D.,
San Francisco, Cal.

NITROUS OXID-OXYGEN ANESTHESIA.
MARY E. BOTSFORD, M.D.,
San Francisco, Cal.

INTRAVENOUS ANESTHESIA.
C. L. CANDLER, M.D.,
Detroit, Mich.

American Journal of Surgery

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F. HOEFFER McMECHAN, A.M., M.D., *Editor*
Cincinnati, Ohio, U.S.A.

JANUARY EDITORIALS. **1916**

ADVANCING THE CAUSE OF ANESTHESIA AND PROMOTING TIE INTERESTS OF ANESTHETISTS.

The SUPPLEMENT is now in a position to report progress all along the line in promoting the interests of anesthetists and advancing the cause of anesthesia.

Through the influence of THE INTERSTATE ASSOCIATION OF ANESTHETISTS, the States of Ohio and Georgia have announced through their Medical Boards that hereafter the administration of anesthetics by unlicensed anesthetists will be considered a violation of the existing Medical Practice Acts, and will be prosecuted as such. Also physicians, surgeons and hospitals persisting in the employment of unlicensed anesthetists will be disciplined by these Boards. An exhaustive canvass is being made in these states to secure evidence of violations of the law upon which the State Boards can take actions.

The Pennsylvania State Medical Board is going a step further and its action contemplates putting an end to the employment of unlicensed medical graduates as assistants in operative procedures. This will necessitate graduates securing their license to practice before taking up their internships, and will end the abuse of the nurse-anesthetist, automatically.

At its November meeting the NEW YORK SOCIETY OF ANESTHETISTS decided to issue the following circular letter in behalf of a legislative campaign it is initiating to limit the administration of anesthetics to licensed practitioners.

"To the Medical Society of the County of——,
of the State of New York,

At the next session of the New York Legislature, there will be introduced a bill to amend the Public Health Law, Article 8, Section 160, Paragraph 7, by adding the words: *'or shall administer a general anesthetic,'* so that said Paragraph 7, when amended shall read: 'A person practices medicine within the meaning of this article, except as hereinafter stated, who holds himself out as being able to diagnose, treat, operate or prescribe for any human disease, pain, injury, deformity or physical condition, and who shall either offer or undertake, by any means or method to diagnose, treat, operate or prescribe for any human disease, pain, injury, deformity or physical condition, or *who shall administer a general anesthetic.*'"

"The New York Society of Anesthetists believes that this proposed amendment is just, both to the profession and to the public, and urges the Medical Society of the County of ———— to give it its official endorsement.

Respectfully submitted,
NEW YORK SOCIETY OF ANESTHETISTS,
H. Clifton Luke, M.D., Sec'y."

This legislative campaign is worthy of the united support of the medical and dental professions of the State of New York.

The NEW YORK SOCIETY OF ANESTHETIST also took a progressive step at its recent meeting to increase its membership, especially by admitting dentists, who are active in the interests of anesthesia, to Associate Membership.—F. H. M.

SOME HISTORIC DATA REGARDING NITROUS OXID-OXYGEN ANESTHESIA.

As Dr. Roland E. Skeel in his recent paper before the New York Society of Anesthetists requested some additional information regarding the historical development of nitrous oxid-oxygen anesthesia, the following facts are submitted, without any desire to detract from the pioneer work of Dr. Ernest E. Brown or Dr. Charles K. Teter, and the efforts of the Lakeside Hospital surgical clinic to establish this technic of anesthesia as a routine method.

It has been generally overlooked that Horace Wells and his associates Drs. Ellsworth, Marcy and Evans, after using both ether and nitrous oxid for major surgical operations, discarded the former as the anesthetic of choice in favor of the latter, and used it in such procedures as amputations of the breast and scrotum. So popular did nitrous oxid become, at this time, that its use for painless tooth extractions was advertised in the Hartford Courant.

The progressive step of Dr. E. A. Andrews, in 1868, of combining oxygen with nitrous oxid, did not receive the attention it deserved until in 1879, after experiments by Paul Bert, M. Claude Martin of Lyons, France, built a chamber for the administration of nitrous oxid and oxygen, under pressure, and he and M. Labbe and M. Pean performed major operations under entirely satisfactory anesthesia maintained by 88 per cent. nitrous oxid and

12 per cent oxygen under an atmospheric pressure of 110 cm.

The first successful attempt to administer nitrous oxid and oxygen at ordinary atmospheric pressure by means of an apparatus capable of regulating the proportions of the two gases, was made by Hillischer of Vienna, and it was the report of his work that directed Sir Frederick Hewitt's inventive genius to the solution of the problems involved. After exhaustive experiments at the Dental Hospital of London, Hewitt presented a report on the subject to the Odontological Society, in 1892, and exhibited his perfected apparatus.

Although Hewitt developed this technic and his apparatus primarily for dental anesthesia, he soon adapted it to longer surgical operations, and reported its use in such procedures as Syme's amputation, lithotrity, amputation of the breast, excision of vericose veins, varicocele, ossilectomy, resection of the patella, intra-uterine operations, and *the dressing of wounds and readjustment of splints.* His longest administration lasted 52 minutes, although in March, 1902, an administration of nitrous oxid-oxygen anesthesia lasting 135 minutes was reported to the London Society of Anesthetists. Hewitt not only perfected an apparatus for the administration of nitrous oxid-oxygen in variable percentages, but also investigated the physiological basis of this form of anesthesia, and its relations to both operative procedures and types of patients.

From 1860-90 operations of varying duration were reported by different observers under nitrous oxid and air. The first systematic endeavor to formulate this technic was made by Dr. George Brush of Brooklyn, who in 1890 perfected an apparatus with a sliding valve, and maintained anesthesia with nitrous oxid and air for operations lasting upwards of an hour.

Clover and Coleman devised and used a nose-piece for the prolonged administration of nitrous oxid for dental operations, and later Coxon (1898) used the mouth-spoon, while Harvey Hilliard in 1902 introduced naso-pharyngeal tubes for the administration of prolonged nitrous oxid anesthesia. Coleman and Patterson revived the nasal inhaler in 1898-99, and in 1902 Kirkpatrick introduced the controllable expiratory valve, for the nasal administration of nitrous oxid and oxygen.

Since these preliminary investigations improvements have followed closely upon each other, and the anesthetists of the United States and their surgical confrères have vied with each other in perfecting this method of anesthesia, which in expert hands is so safe and pleasant for the patient.—F. H. M.

Newer Apparatus

Editor's Note: From time to time this Department will publish Illustrations and Technical Details of the Newer Apparatus for Anesthesia and Analgesia.

THE NEW McKESSON HOSPITAL UNIT FOR NITROUS OXID-OXYGEN AND ETHER ANESTHESIA.

The new McKesson Hospital Unit for nitrous oxid-oxygen and ether anesthesia presents some improvements in mechanism that enable the expert anesthetist to more accurately manipulate and gauge his anesthesia. The large tanks with their pressure gauges and automats for controlling the flow to the apparatus, mounted on a movable base, are already familiar to readers of the SUPPLEMENT.

The apparatus itself consists of two automatic pressure

gauges, controlling the flow of nitrous oxid and oxygen to the mixing valve-chamber, which in turn controls the percentage mixture of the gases delivered to the patient This part of the mechanism is now supplemented by a screw for increasing or decreasing the pressure of the gases without changing the percentages of the mixture. This pressure screw controls the automats attached to the rubber-bag containers for the nitrous oxid and oxygen, and effectively regulates the inflation and deflation of these bags.

From the mixing chamber the anesthetic gases pass into the tube connected to the mask, nasal inhaler, or mouth spoon or oral inhaler. A valve is provided, however, to throw into action the fractional rebreathing bag, by means of which fractional rebreathing can not only be used, but an economic saving of the anesthetic gases accomplished. Attached to the rebreathing bag is the ether container, by means of the regulating device of which the anesthetist can add any required percentage strength of ether vapor to the nitrous oxid-oxygen anesthesia to produce the proper degree of muscular relaxation.

An emergency oxygen valve is provided for perflation of the lungs in emergencies, although McKesson has repeatedly shown that in resuscitation, oxygen by fractional rebreathing to conserve the carbon dioxid tension, for stimulating respiration and venous tone, is the better procedure.

Society Proceedings

Membership in a society devoted to your specialty is an essential to success.

In pursuance of its policy of *service* the SUPPLEMENT presents abstracts of the following papers of interest to medical and dental anesthetists, and recently read before various societies.

GENERAL ANESTHESIA VERSUS LOCAL IN NOSE AND THROAT SURGERY.*

JOSEPH C. BECK, M.D.,
Chicago, Ills.

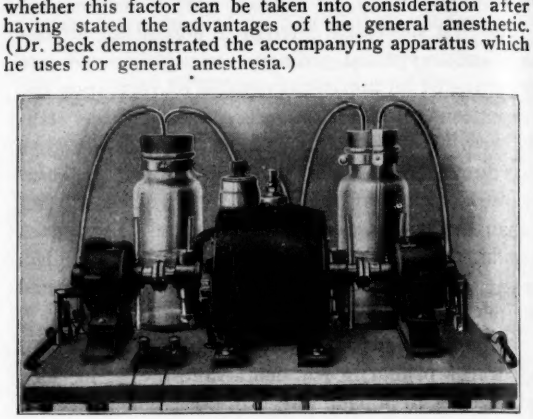
Dr. Joseph C. Beck first considered local anesthesia, referring especially to the work of Kohler with cocain. Owing to the possibilities of cocain poisoning there was a demand for substitutes, of which tropo-cocain, alypin, eucain, beta-eucain, novocain, stovain, quinin and urea hydrochlorate are some of the most important that have been recommended. In addition, it was found that local applications of solutions of adrenal gland extracts aided the anesthetic effect, as well as prevented rapid absorption of the poison. Up to the time novocain was brought forth as a local anesthetic it had been the speaker's experience that none of the above mentioned substitutes did the work as well as cocain, and even now he finds that in some cases he has to resort to it in order to get anesthetic effects. He only remembers one distinct case of cocain poisoning in a boy nine years old, followed by perfect recovery.

The speaker's experience with spinal anesthesia by means of stovain, as advocated by Jonnesco, had not been satisfactory.

Under general anesthesia he considered ether, chloroform, nitrous oxid, alcohol, chloroform and ether (A. C. E. mixture), bromid of ethyl, chlorid of ethyl, somnoform, morphin, scopolamin and hyoscin. From 1895 to 1901 it was his custom to employ chlorofrm as the general anesthetic in preference to ether, and he could say unhesitatingly that the results were much more satisfactory, as he never had a death from its use, and did have one death from ether. Nevertheless, following the general cry against chlorofrm, he gave up its use, only employing it in rare instances. He uses it almost exclusively in infants, especially in cleft palate operations. The anesthetic that he employs is ether, and he gave the method of its use in nasal, mouth and throat operations.

Dr. Beck wished to call attention to one of the most important question as to the choice of a local or general anesthetic. He referred to the work of Crile on the effect of mental shock or fear on the repair of the tissues after operation, and on the deleterious effect of this mental shock and fear on the nervous system. He is sure that every operator has observed what is termed postoperative neurosis, which is analogous to the posttraumatic or postpartum neurosis. He did not wish to say that one never sees the postoperative neurosis in general anesthetic cases, but certainly they are not nearly so frequent. He believes that if one would follow the teaching of Crile in applying the method of anoci-association, by blocking off locally the nerves by injecting novocain solution, one would see fewer of these cases following the use of general anesthesia.

Another important point in the choice of a local or general anesthetic is the question of pain that is experienced even in a thorough local anesthetic. Pain is a relative phenomena, and different individuals are more or less susceptible to it. A still more important factor is the ability to do thorough removal of the pathologic prosesses and the proper stopping of bleeding and application of dressing, which often is not possible in a very nervous patient. A fourth reason for the use of general anesthesia in preference to local is the strain on the operator when working under local anesthesia. The one great advantage in the local anesthetic is the saving of time both for operator and patient, but Dr. Beck doubts very much whether this factor can be taken into consideration after having stated the advantages of the general anesthetic. (Dr. Beck demonstrated the accompanying apparatus which he uses for general anesthesia.)



The illustration shows the construction of the Beck-Mueller combined ether-vapor and aspirating apparatus for continuous anesthesia in oral surgery. The motor is especially wound for the proper operating speed of the blower and vacuum pump. It will operate continuously without overheating. One side of the armature shaft drives a rotary vacuum pump, the other end a rotary pressure blower, both directly connected to the motor shaft by universal couplings. Both pumps are operated synchronously, and pressure and vacuum can be minutely controlled by a special valve, which acts automatically.

In use the compressed air passes through the ether and ether-vapor is formed, which passes into the heating chamber, thence through a filter and on to the patient, by means of nasal, pharyngeal gag or intratracheal attachments, as required. The heating unit, which is placed under the ether bottle, and the current supplying heat to the heating chamber, as well as to the motor itself, are all operated by a single switch. Sufficient vacuum is produced for all classes of work, not only for operative procedures in the nose and throat, but also in gynecological and abdominal surgery. Connection for the attachment of a manometer for intratracheal insufflation is provided, as well as a valve for connecting up oxygen containers.

* Read before the Chicago Laryngological and Otological Society.

SPINAL ANESTHESIA IN ANAL AND RECTAL SURGERY.*

WILLIAM H. KIGER, M.D.,
Los Angeles, Cal.

The one thing that prompted me to write this paper was a statement that I found in a recently published book on "Diseases of the Rectum and Colon" which read: *"Spinal anesthesia has a very limited field of usefulness. Indeed, one is hardly ever justified in using it in Rectal work."* After a personal experience in over five hundred rectal operations without a single unpleasant result I am constrained to differ from the author, and forced to the opinion that he has not given spinal anesthesia a fair trial, or that he, mayhap, did not use the proper agents. I first began to use this form of anesthesia over five years ago, in my clinic at the County Hospital, in cases only where a general anesthetic was contraindicated, such as cardiac troubles and Bright's disease. I found that it had no ill effect in any of these and its use was so ideal that I soon began its use in most all cases in my clinic work, and in many of my private cases. I should like it understood that I am not comparing this method with local anesthesia, for the latter has its distinct place in rectal work. I am attempting to show its superiority over chloroform and ether in this class of operations especially. You are all familiar with the unpleasant things that happen when an attempt is made to dilate the sphincter muscle, if the patient is not profoundly under the effect of one or the other of the two

* Read before the American Proctologic Association in San Francisco, June 21-22, 1915.

agents mentioned, and your great concern during the operation. None of these unpleasant things happen during spinal anesthesia. Let me call attention, too, to its ease of administration. It requires an expert to administer a general anesthetic, it does not to give spinal anesthesia. The proper point to inject the fluid containing the agent injected; and his services are over with, as there is no after attention necessary. It requires no greater skill than to do an ordinary spinal puncture in which to obtain fluid for examination, and this is so simple that it has become common practice in most hospitals at least. Again, the saving of time in doing an operation is of great consideration, especally in doing clinical work. If need be, the surgeon can administer the anesthetic, and thus do away with one assistant. In my clinic I frequently have as many as ten cases to operate on in one forenoon. The delays incident to doing an operation under a general anesthetic makes it impossible to operate on this number in this given length of time, and more assistants are required. In doing a rectal operation it is necessary to have complete relaxation of the sphincter muscle—under spinal anesthesia you have it without a forcible dilatation, thereby often injuring the parts. The patient is conscious, and you have simply to ask him to strain and the gut will easily protrude through the relaxed muscle, thus making the operation for hemorrhoids easy of doing.

One very great advantage in this method of operating is the avoidance of shock. According to the Crile theory of Anoci-Association stimuli travel to the brain from the source of injury, thereby producing shock; with the spinal cord blocked no shock can occur. I have never yet witnessed any shock after thus operating, although I have spent a considerable time in operating, as for instance in the resection of the rectum. The comparison between the agents to produce general anesthesia and the method in relation to shock is very well shown in the recitation of two cases recently operated on, both cases being Carcinoma of the rectum. One I did under spinal anesthesia. The other patient refused it, preferring to take ether. The one taking the spinal method had no shock whatever, the one taking ether had severe shocks. Another thing to be considered is nausea, vomiting, etc. How often have these things annoyed both you and the patient, often prolonging the operation, and lasting for hours after the operation—under spinal anesthesia no such unpleasant conditions arise. Leaving off that *one meal* before operation is not necessary. Again, the consciousness of your patient is of very great advantage, you can consult him as you proceed, if thought necessary. This was beautifully illustrated a short time ago at the County Hospital in the general surgical clinic. The operating surgeon did not think, when beginning to operate, that it would be necessary to amputate the leg, but saw later that it was necessary. He therefore explained to the patient, who gave his consent. At the hospital it is the rule to require the consent of the patient for or before doing any operation. Under this method you know that the condition of your patient is good. They generally converse with you during the operation, frequently laugh or jest, and wave you a salute as they leave the operating room. How different compared to the groans, moans and cries that follow in the wake of chloroform or ether. In my experience there are but few people but dread to be put to sleep under an anesthetic when you say to him that he does not have to be put to sleep and that he will suffer no pain, with what gladness he accepts it. If you have to operate the second time on the same patient you will have no trouble in getting his consent.

No doubt but that all of you have had your troubles in anesthetising the alcoholic patient—under this method there will be no trouble, either to you or the patient. Another item is the cost of both the anesthetic and its administration. These are saved to your patient, and furthers your praise. The cost of a novocain or a tropacocain injection is only a few cents.

PREPARATION OF PATIENT.

The preparation of the patient for spinal anesthesia is very simple. There is no meal to be omitted—a simple purgative the evening before the operation, and a free washing out of the bowel just before operating, is all.

The technic is also very simple and easy of application. The patient is first put on the operating table in a sitting position, with the feet resting on a chair, and elbows on his knees with his back bowed. The field of injecting the spinal column is now painted with benzine and iodine. The anal and rectal region prepared as is your custom. The main and essential thing is to select the proper point for injection. The best is to inject between the vertebrae lowest down. The skin and deeper structures around this point are now infiltrated with a ½ per cent. solution of novocain, which renders the spinal puncture practically painless. Insert the special needle slowly and firmly to prevent breaking. When fully inserted a drop of spinal fluid will be noticed oozing from the needle; (place your finger over the top of the needle) attach the small glass syringe, in which has been previously placed one grain of sterile crystals of novocain or tropacocain, draw out enough of spinal fluid to dissolve the crystals, use pressure on the syringe to inject this fluid, and agent, into the space. This completes the operation and the small skin wound is closed by the application of collodion. The patient is now placed in position on the operating table for the rectal operation. I imagine that the reason that some object to spinal anesthesia is based upon the fact that cocain was used during the first attempts to produce it and some deaths were recorded; however, my experience as herein recorded shows novocain has supplanted its use, and no danger need be feared. It is the least toxic of all agents used for this purpose, and it is the one used in my clinic to the exclusion of all others. Again, it was urged as an objection to this form of anesthesia that it did, or might be followed by paralysis, neuritis, and various other bad effects, but after five years' experience in the use of novocain I have yet to see any ill effect that could be traced to its use. The only unpleasant symptom that has ever occurred is that a few of my patients have complained of an occasional headache, which usually passes away in a few hours.

I am in the habit of administering a few small doses of strychnia which abates this symptom. I have noticed headache following spinal puncture to obtain fluid for analytic purpose oftener than I have following spinal anesthesia. Especially is this method to be employed in the tubercular patient who misses no meal and needs all the nourishment he can get.

Consolidated Realty Bldg.

EXPERIMENTAL AND CLINICAL OBSERVATIONS ON THE BLOOD-PRESSURE IN SPINAL ANESTHESIA.*

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The use of ether in urology has been attended by certain dangers, the chief of which resides in its effect upon the kidneys. It seemed, therefore, when spinal anesthesia was made practicable, that this method for urological cases would prove to be ideal. In many instances such has been the case. In others, we have been distressed by the severe and alarming fall of blood-pressure which accompanied and was apparently due to this method of anesthesia.

In a number of our spinal anesthesias in which the blood pressure was followed there was a marked fall, which in some cases amounted to 100 mm. of Hg. In several cases the blood pressure fell even below 45 mm. Hg., which was the lowest level recorded by the clinical apparatus. These extremely low pressures occurred only in a small proportion of spinal anesthesias; in most instances the blood pressure fell to 75 or 80 mm. Hg. Always with the more pronounced drops, and at times with the drops of moderate degree the patient exhibited the signs of shock—namely, pallor, sweating, nausea, air hunger and a pronounced sense of uneasiness. The pulse always remained between 60 and 90, and did not increase in rate as the blood-pressure fell. The above mentioned signs appeared in from 10 to 20 minutes after the introduction of the drug, and passed off as the blood-pressure began to rise, which it usually did 10 to 15 minutes later. Several cases which had been through this rapid change of blood pressure had cardiac decompensation within 24 to 48 hours

* Read before the New England branch of the Urological Association.

after operation, and although the influence of the operation (usually suprapubic prostatectomy) could not be disregarded, it seemed to us that the spinal anesthesia might well have been an important factor in disturbing a heart which was perhaps not in the best condition to go through such an ordeal. It is fair to say that none of the cases in which a minor operation or cystoscopy alone was done had cardiac decompensation afterwards. It may be that as most of the cases of this class were young men their cardiovascular systems were better able to stand the fluctuations in blood pressure, whereas the older men, who had prostatectomies, were often in advanced arteriosclerosis.

However that may be, it is a fact that in a considerable percentage of cases the blood-pressure fell to a disturbing degree. Physiologists have found that in animals in which a blood-pressure of less than 35 mm. Hg. is induced for more than 15 minutes a number of nerve cells are actually killed from anemia and the consequent lack of nutrition. It is not unlikely that the very low pressures sometimes seen during spinal anesthesia contribute to post-operative shock through depriving the higher centers of their proper blood supply.

The occurrence of this fall in blood pressure in some cases seemed to us a danger grave enough to contraindicate spinal anesthesia in those very cases in which its use, from other points of view, was most desirable. With a view to finding out the cause of the low pressure, and if possible a means of preventing it, I took the question to Prof. W. T. Porter, and in the laboratory of comparative physiology of the Harvard Medical School we attempted to solve it through experimental methods.

The cat was the animal selected. Fifty were used, and as in many of them more than one experiment was done, we gathered records of 74 different injections.

The cats were lightly anesthetized and then stretched on the cat board. The carotid artery was exposed, connected with a membrane manometer, and a cannula was put in the trachea so that artificial respiration could be established. We found that the changes in blood pressure and the tests of anesthesia were so much influenced by muscular reactions that we could not tell for sure just what was happening, and if the cat became too deeply etherized the reflexes disappeared. Therefore, we abandoned the use of ether throughout the experiments and used curare alone. The animal was turned over on its belly and, as I found that it was impossible to get the needle into the dura with certainty without doing a laminectomy, in every case laminectomy was done. We are well aware that there are certain forces within the spinal sac which keep up the movement of the spinal fluid. It is known, for instance, that respiration tends to cause movements of the spinal fluid; this effect must have been more or less offset by these windows through the spine. Also in considering the effect of gravity one must allow for the influence of atmospheric pressure when the tube is open at the end. We tried to make allowances for these sources of error, and we feel that the information obtained is substantially accurate. The needle was inserted through the dura and the fluid injected into the cerebro-spinal fluid at the lower lumbar region, where the cord becomes very small. In that region the needle can be inserted perpendicularly into the long axis of the cord. Higher up the needle has to be inserted more or less parallel with the axis of the cord, and the direction of the injection is thereby changed. We have endeavored to consider all these factors in noting the principles underlying the distribution of the drug.

Tropacocain and novocain, with and without adrenalin, were the drugs used. Adrenalin alone injected into the spinal canal was found to have no effect upon the blood-pressure.

The literature from 1900 to March, 1915, contained no conclusive work on the blood-pressure during spinal anesthesia. A number of writers mentioned the fall in blood-pressure, but attributed it to the effect of the drug upon the bulbar centers. In our experience with cats under ether alone, if the injection was made into the spinal sac below the phrenic nerves (5th cervical) and ascended to the medullary centers, respiration was always paralyzed. In the 125 cases in which spinal anesthesia was used on the genito-urinary service at the Massachusetts General Hospital no case showed respiratory paralysis. The fall of blood pressure, therefore, cannot be attributed to the influence of the drug upon the bulbar centers.

It has been shown that the blood-pressure is dependent largely upon the condition of the blood vessels of the splanchnic area. The mechanism by which the pressure in this area is regulated consists upon its efferent side of three links: (1) the bulbar centers, (2) the efferent vasomotor tracts which run in the antero-lateral columns of the cord, (3) the vasomotor fibres which pass out with the anterior roots of the cord from the 5th dorsal to the 3d lumbar segments. (Howell: American Text-book of Physiology, vol. i, p. 206.)

In our experiments it appeared that all of these links of the vasomotor mechanism were susceptible to paralysis by novocain. When, however, the drug is injected in the lumbar region, as in spinal anesthesia, its effect as it diffuses throughout the spinal fluid is felt first and chiefly by the vasomotor fibres of the anterior roots.

As a result of our work, the following conclusions may be drawn:—

1. The blood-pressure can be lowered as much by spinal anesthesia as by section of the cord in the cervical region.

2. The greatest fall was caused by injection of the drug in the thoracic region, where the vasomotor fibres which supply the splanchnic area leave the cord.

3. This part of the vasomotor mechanism is the first affected by the drug when the injection is made in the lumbar region.

4. The extent of diffusion of the drug within the dural sac appears to be influenced more by the bulk of the solution injected than by any other one factor.

5. A given amount of drug in a concentrated solution diffuses less and consequently lowers blood pressure less than does the same amount of drug in a more dilute solution.

6. The greatest effects upon blood pressure were noted when adrenalin was combined with novocain.

7. Entire fixation of the drug does not take place within 20 minutes after the time of injection.

8. When a solution of greater specific gravity than spinal fluid is used, the extent of diffusion may be increased by gravity.

9. Attempts to raise the blood pressure by the intravenous injection of pituitrin or adrenalin gave only a very transient rise.

BUCKLEY'S PASTE AS A DESENSITIZING AGENT.*

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Obviously any method or remedy for the elimination of pain in filling teeth is more or less dangerous when placed in the hands of the profession in general.

The dental pulp is a highly sensitive and highly vascular structure that is keenly sensitive to shock; and whether the shock be traumatic, mechanical, or chemical matters little in so far as its death is concerned, if that shock be sufficiently intense.

TRIOXYMETHYLENE AND ITS ACTION.

Trioxymethylene, the main ingredient in Buckley's desensitizing paste, is polymerized formaldehyd, and formaldehyd is a violent irritant to animal tissue, therefore the use of the paste in all cases of deep-seated caries should be attended by the most rigid care and precaution. In other words, due consideration must be given to diagnosis and to prognosis if subsequent disagreeable complications are to be averted.

Parenthetically, we do not advocate the indiscriminate removal of vital pulps in adult teeth, but we do contend that their removal under aseptic conditions in cases with a clearly doubtful prognosis is to be considered preferable to awaiting until the pulp dies and becomes septic.

MODE OF APPLICATION.

As a desensitizing agent Buckley's paste occupies a position peculiarly unique and beyond question, provided it be sealed in the cavity. That is the only objection to its use that we have to record up to the present time, viz., it must be sealed in the cavity. Any of the plastics, prefer-

* Read before the Susquehanna Dental Association of Pennsylvania at its annual meeting, Wilkes-Barre, May 18, 1915.

ably one of the temporary cements or temporary stopping, may be used for that purpose. The writer prefers where possible to use either Gilbert's or Fell's temporary stopping; both become very plastic at low heat—Fell's at even a lower heat than Gilbert's—and they are easily and quickly molded into the cavity without undue pressure. They have the additional advantage, if properly manipulated, of forcing the gum tissue away from the cervical margin of the cavity in those cases where this is necessary, and as a sealing medium they leave nothing to be desired so far as my observations have gone.

Our regular routine consists in excavating and filling the cavity on the day following the application of the paste, but for the following various reasons that procedure is not always possible: (1) It occasionally happens that more than one application of the paste is necessary in order to desensitize all the sensitive area for thorough cavity preparation, this applying more especially to superficial cervical areas, or to cases requiring considerable cutting in sound dentin. (2) Separation of the teeth may be essential to a complete anatomical restoration, and may not have been obtained prior to the application of the paste. (3) Time, either the patient's or the operator's, may not permit its employment.

EFFECT OF THE PASTE.

This brings us to a consideration of two valuable features of the paste. After a few hours, its chemical action seems to cease, but the desensitizing effect lasts for several days, which means that we have ample time in which to do painlessly any operation desired or essential in so far as the cavity to which the paste has been applied is concerned.

It is to be noted that the action of the paste is confined to the tooth area upon which it is placed, and that it has no numbing effect upon the pulp.

Placing the paste in a mesial cavity does not desensitize a distal or a cervical cavity in the same tooth, nor will the entire surface of the cavity be desensitized unless the paste is in contact with or has access to the entire sensitive area.

In view of their vitality being subsequently restored, we are inclined to think that the fibrillæ are paralyzed rather than that their vitality is destroyed.

The writer had an approximo-occlusal gold filling in an upper first molar which had decayed at the cervix, the decayed area being exceedingly sensitive. The filling was removed, and desensitizing paste placed upon the sensitive area only. Two days after the application of the paste all that area was cut away without any discomfort whatever. But when it was found necessary to do some cutting for retention at the occlusal aspect, the dentin was as normally sensitive as though no paste had been used—and it is to be noted that no caries was present at or even near to that point.

PRECAUTIONS.

A precaution that should invariably be observed in restoring cavities with metal fillings is to use nonconducting linings in all those cases which experience has taught us will be sensitive to thermal change. A cavity in which the paste has been used does not respond readily to change of temperature at the time of operating, but it should not be taken for granted that it will not subsequently do so. In fact, we consider it excellent practice to use a non-conducting lining under every metal filling, whether desensitizing paste has or has not been used.

It occasionally happens that after applying the paste, an uncomfortable feeling in the tooth is experienced; rarely does this amount to a distinct ache, it may rather be characterized as a *growl*, and is due, we assume, to the irritating property of the formaldehyd.

In very deep-seated cavities, it not infrequently happens that a major portion of the decay can be removed with but little if any pain, and especially is this so in that part of the cavity immediately over and surrounding the pulp. In all such cases it is advisable to cover the dentin immediately overlying the pulp with some protecting material such as temporary stopping or one of the cavity linings, or both, and then apply the paste directly to the sensitive area. We thus protect the pulp from a too direct action of the formaldehyd, and as a consequence shock through irritation is greatly minimized if not entirely eliminated.

It is really surprising what a small quantity of paste is required to accomplish the desired result. *One grain of the preparation is sufficient for about fifteen applications. On this basis the amount necessary for one application contains neothesin 1/300 grain, thymol 1/270 grain, and trioxymethylene 1/43 grain.* As a precautionary measure, we would emphasize the importance of using only the minimum quantity, but placing that quantity where it is required, keeping in mind constantly that its use should be accompanied with cool judgment and intelligence rather than effusive enthusiasm.

FURTHER CLINICAL DATA NEEDED TO PROVE HARMLESSNESS TO THE PULP.

The important problem that we have to solve at this time is, Has the paste any deleterious action upon the dental pulp, and, if so, under what conditions? That cannot be solved by any hit-or-miss procedure of practice, either in the application of the remedy or the records of the case in which it is used.

CONCLUSION.

Six months' use of the paste by the writer in various cavity conditions, without any unfavorable results, leads to the conclusion that at last we have a formula which as a desensitizing agent is distinctly worthy of a most prominent place in our dental armamentarium. It is not only a wonderful relief to our patients to know that they are going to be practically free from pain during excavating and filling operations, but it relieves the operator of a great burden. Furthermore, its use reduces scientific cavity formation to a reality in all those cases in which heretofore, owing to extreme sensitiveness, a compromise had to be made.

Index and Abstracts

A Résumé of the International Current Literature of Anesthesia and Analgesia

EDITOR'S NOTE: Authors of pertinent articles, who desire to have them indexed and abstracted, are cordially invited to send copies of the journals containing their contributions, direct to the editor, immediately on publication. Also the receipt of reprints for filing and reference will be duly appreciated.

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